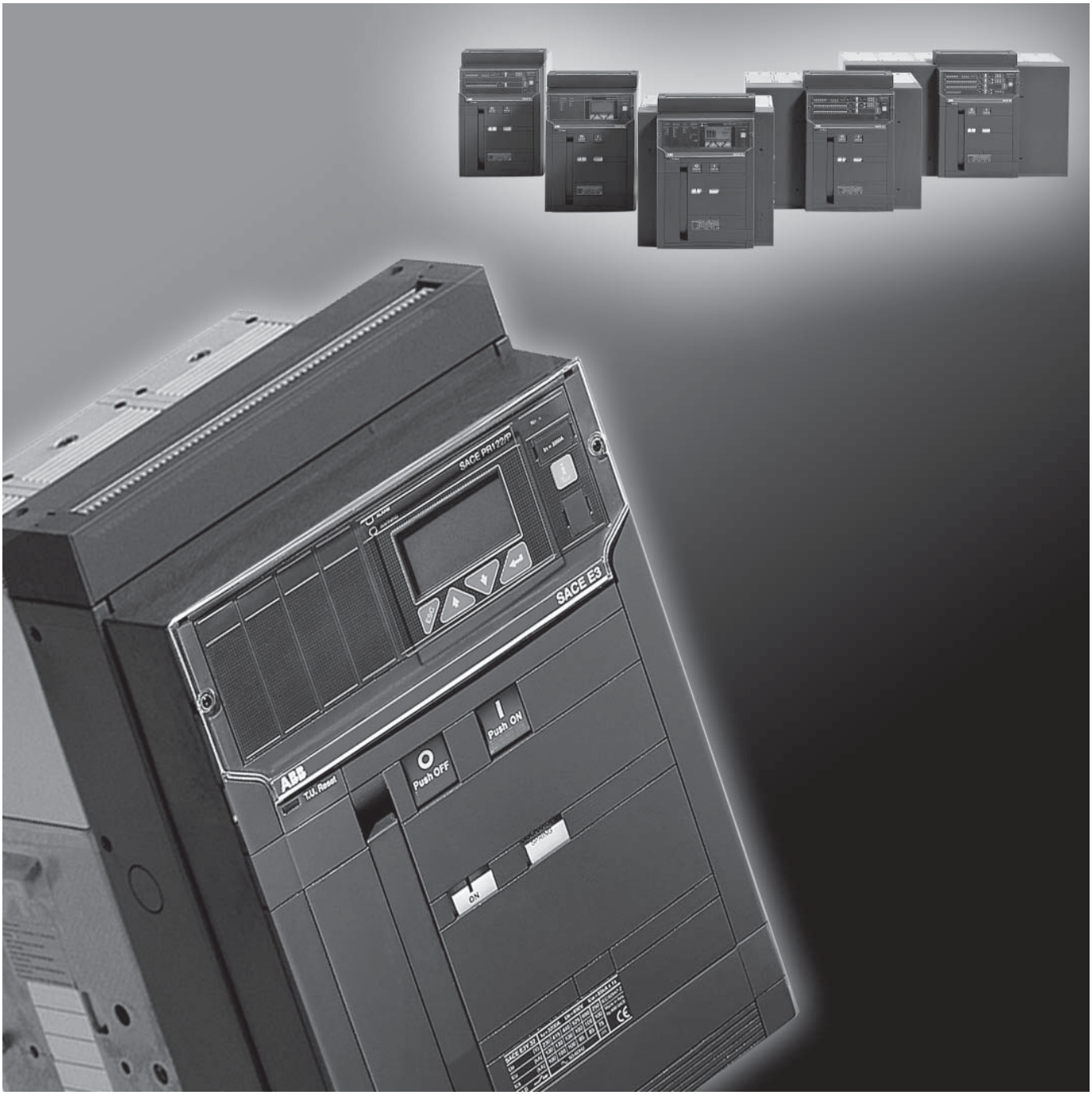
Installation and
service instructions

Installation, service and maintenance instructions for low voltage air circuit-breakers

1SDH000460R0002 L5439

Emax



Dwg.		Resp. Off.		Title **Installation, service and maintenance instructions for low voltage air circuit-breakers**	Language **EN**
App.		Take over Off.			
Model	L2234	L4681	L5439	Apparatus **Emax**	Scale
	L2778	L5179			
ABB SACE				Doc. no. **1SDH000460R0002**	

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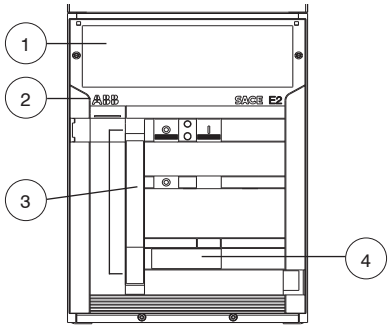
1. Description

1.1. General characteristics

The SACE Emax series of circuit-breakers and disconnectors consists of a steel sheet structure which houses the operating mechanism, the poles and the auxiliary parts. Each pole, insulated from the others, contains the circuit-breaking parts and the current transformer of the corresponding phase.
The structure of the poles differs according to whether the circuit-breaker is selective or current-limiting.
The fixed version circuit-breaker has its own terminals for connection to the power circuit; in the withdrawable version the circuit-breaker comprises the moving part of the apparatus, which is completed with a fixed part fitted with the terminals for connection to the power circuit of the installation. The moving part and the fixed part coupled by means of special contacts installed in the fixed part.

1.2. External front view of the circuit-breaker



1 PR121, PR122 or PR123 electronic microprocessor-based release
2 Trade mark
3 Operating and control parts of the operating mechanism and release tripped signals
4 Rating plate

Fixed circuit-breaker

Fig. 1

1.3. Rating plate

1.3.1. Circuit-breaker rating plate

Switch example

SACE E2B 16		Iu=1600A Ue=690V Icw=42kAx1s				
Ue	(V)	230	415	440	525	690
Icu	(kA)	42	42	42	42	42
Ics	(kA)	42	42	42	42	42
cat.B		~ 50-60Hz				

IEC 60947-2 made in Italy by ABB-SACE

Fig. 2a

1.3.2. Disconnector rating plate

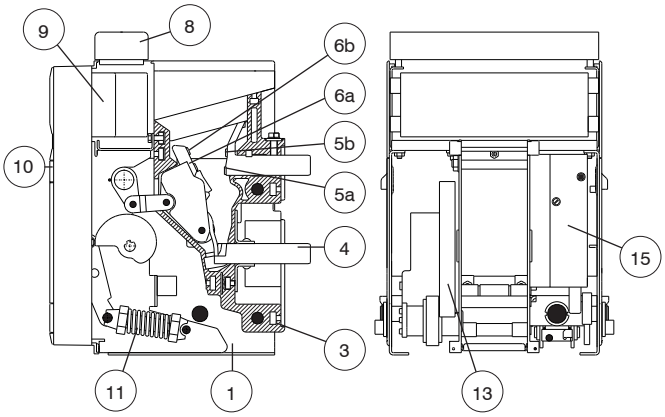
Circuit-breaker example

SACE E2B/MS 16		Iu=1600A Ue=690V Icw=42kAx1s			
Ue	(V)	400/415	690	250	500
Ie	(kA)	1600	1600	1600	1600
Cat.		AC - 23A		DC - 23A	
		~ 50-60Hz		1P ⎓ 2P	

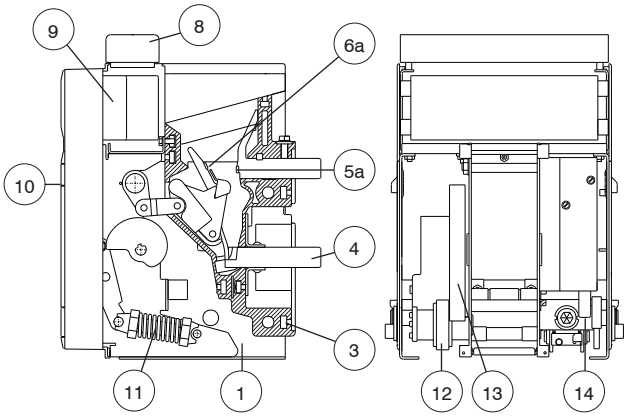
IEC 60947-3 made in Italy by ABB-SACE

Fig. 2b

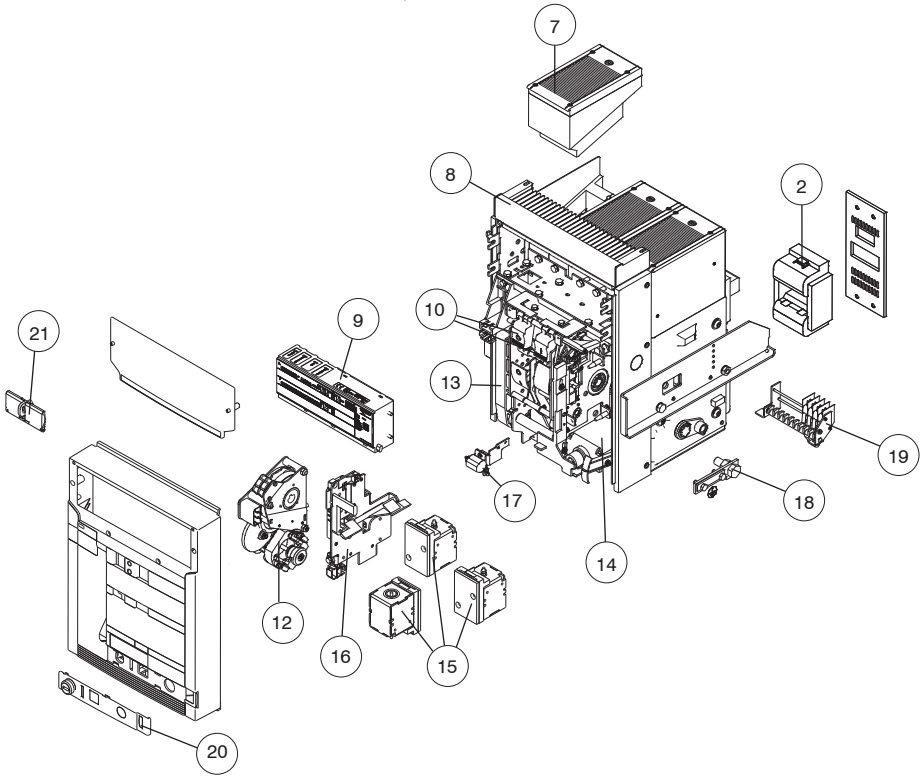
1.4. Moving part construction characteristics



Selective circuit-breaker



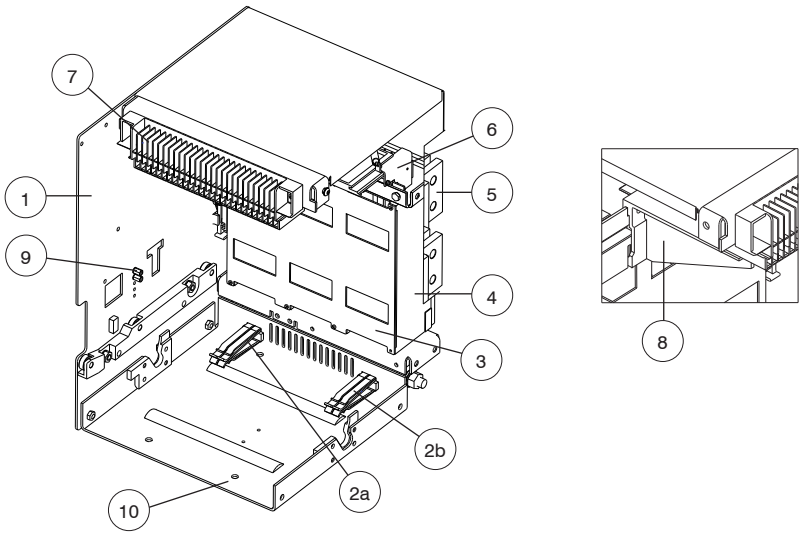
Current-limiting circuit-breaker



1 Supporting structure made of steel sheet
2 Current sensor for protection release
3 Terminal supporting insulating box
4 Horizontal rear terminals
5a Main fixed contact plates
5b Fixed arcing contact plates
6a Main moving contact plates
6b Moving arcing contact plates
7 Arcing chamber
8 Terminal box for the fixed version-Sliding contacts for the withdrawable version
9 Protection release
10 Circuit-breaker closing and opening mechanism
11 Closing springs
12 Spring loading geared motor (on request)
13 Lever for manually loading the closing springs
14 Racking-out device (only for withdrawable circuit-breakers)
15 Service releases (shunt closing release, shunt opening release, undervoltage release)(on request)
16 Support for releases
17 Operation counter
18 Earthing
19 Auxiliary contacts
20 Key lock and padlocks in the open position – extracted test – extracted
21 Key lock in the open position

Fig. 3

1.5. Fixed part construction characteristics



1 Steel sheet supporting structure
2 Earthing contacts (a: for all versions; b: for E4, E6)
3 Safety shutters (IP20 degree of protection)
4 Insulating terminal support base
5 Terminals
6 Contacts for signalling connected/test isolated/disconnected (on request)
7 Sliding contacts
8 Padlock for safety shutters (on request))
9 Anti-racking-in lock for circuit-breakers of different size
10 Fixing holes (qty 4 for E1, E2, E3, 6 for E4, E6)

Fig. 4

2. Checking on receipt

Examine the state of the material received and its consistency with the content of the order. Should any damage or errors be found on unpacking, which must be carried out carefully, make the relative notification within and not over 5 days from the receipt of the material. The notification must indicate the number of the shipping note.

3. Storage, lifting and weights

The circuit-breaker, protected by an external wooden crate, is fixed by means of screws to the transport pallet or to the bottom of the packing case.
If the circuit-breaker has to remain in the warehouse even for a short time before being put into service, after checking it on receipt, it must be put back in its container and covered with a waterproof sheet.

CAUTION:
- **Use a dry, dust-free room free of aggressive chemical agents as a storage room,**
- **Position the circuit-breaker and any fixed part on a horizontal surface, not in direct contact with the floor, but on a suitable support surface (Fig. 5);**
- **The maximum number of stackable circuit-breakers is indicated in figure 6,**
- **Keep the circuit-breaker in the open position and with the closing springs unloaded to avoid unnecessary stresses and the risk of accidents to the person.**

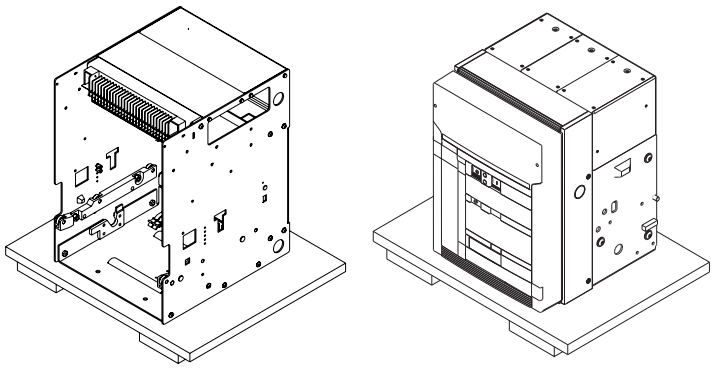


Fig. 5

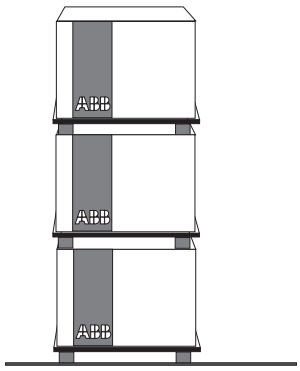


Fig. 6

With regard to lifting, follow the instructions: the circuit-breakers must be placed on a sturdy supporting surface and lifted, preferably, by means of a special fork-lift truck. However, the use of ropes is allowed. In this case, the lifting ropes must be hooked up as shown in the figures (the lifting plates are always supplied with the circuit-breaker).

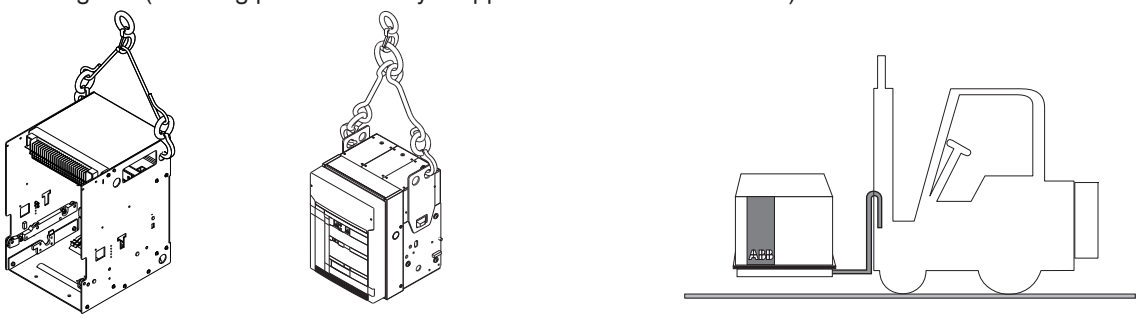


Fig. 7

Table of the circuit-breaker weights (Kg.)

Selective circuit-breaker	Fixed version		Withdrawable version	
	3 poles	4 poles	3 poles	4 poles
E1	45	54	70	82
E2	50	61	78	93
E3	66	80	104	125
E4	97	117	147	165
E4/f		120		170
E6	140	160	210	240
E6/f		165		250

Current limiting	Fixed version		Withdrawable version	
	3 poles	4 poles	3 poles	4 poles
E2L	52	63	80	95
E3L	72	83	110	127

Notes:
- The weights indicated in the table are intended for circuit-breakers complete with PR121, PR122 or PR123 releases and relative current sensors, excluding the accessories.
- The withdrawable version includes the moving part in the same conditions as above, and the fixed part with horizontal rear terminals.

4. Installation

4.1. Installation room

Install the circuit-breaker in a dry, dust-free, non-corrosive room, and in such a way that it is not subject to shocks or vibrations. Where this is not possible, install it inside a switchboard with a suitable degree of protection.
For the preparation of the installation room, please refer to the "Overall dimensions" paragraph, which gives information on the following points:

- minimum installation volumes of the circuit-breakers and derived versions
- distances to be respected for circuit-breakers in compartments
- overall dimensions of the circuit-breakers
- fixing drillings
- compartment door drillings.

The installation, commissioning and any ordinary and extraordinary maintenance have to be done by skilled personnel, with a detailed knowledge of the apparatus.

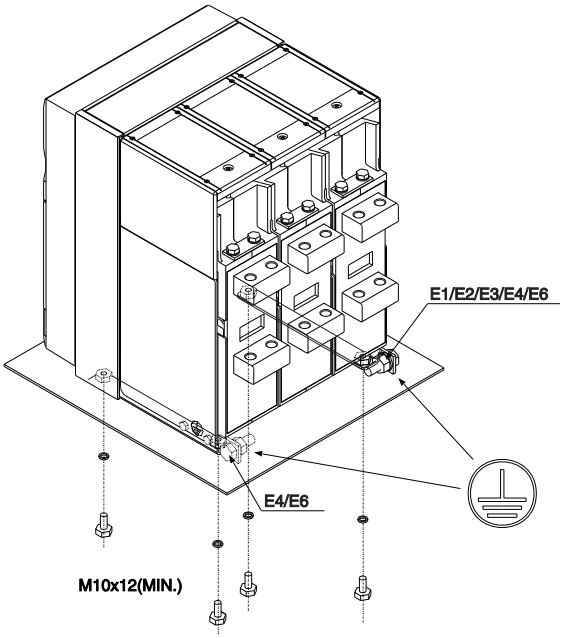


Fig.8

WARNING: The installation, commissioning and any ordinary and extraordinary maintenance of the circuit-breaker and accessories must be performed by skilled personnel, with a detailed knowledge of the equipment.

WARNING ELECTRICAL SHOCK HAZARD:
Disconnect and lock and tag out all electrical power feeds to avoid any potential shock hazard when you are assembling, installing maintaining or removing the circuit breaker from service. Some operations must be performed when the circuit-breaker is energized. In this case, reasonable care and compliance with all safe working practices is required.

4.2. Installation of the fixed circuit-breaker

Fix the circuit-breaker to a horizontal surface using the screws (M10 x 12 min.).

4.3. Installation of the fixed part of the withdrawable circuit-breaker

4.3.1. Preparation of the fixed part

Assembly of the anti-racking-in lock
Before installing the fixed part, it is necessary to check the presence of the anti-racking-in lock for circuit-breakers with different electrical characteristics from those of the fixed part. If the anti-racking-in lock has been supplied separately, proceed to assemble it as follows.

- On the self-adhesive plate (4), find the assembly position of the stop bolts in relation to the circuit-breaker which has to be housed in the fixed part.
- Insert the hexagonal-head screws (1) in the holes found in the previous item as shown in the figure.
- Fix the screws with the washers (2) and the hexagonal stops (3).

Make sure that the anti-racking-in lock corresponding to the one installed on the fixed part is present on the circuit-breaker (moving part).
- Anti-racking-in plate on the moving part (5).

Example for E1B 08 according to the nameplate diagram

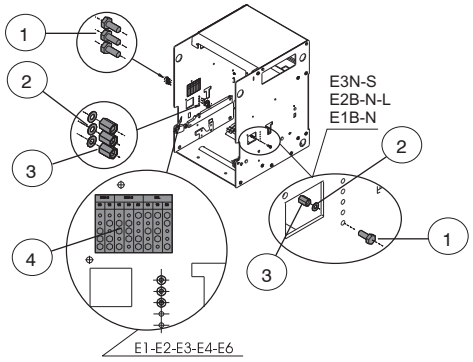


Fig. 9

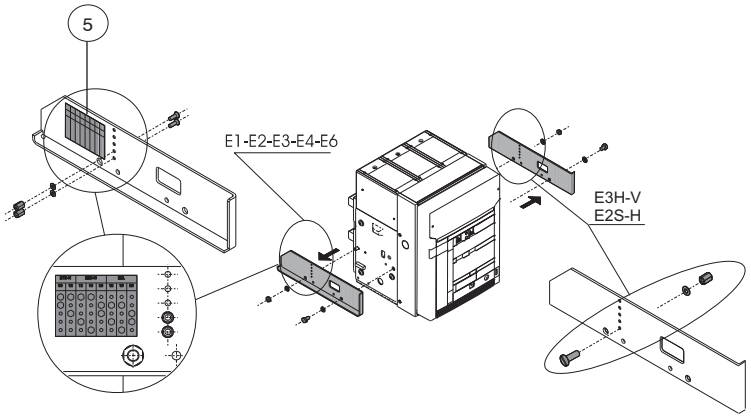


Fig. 10

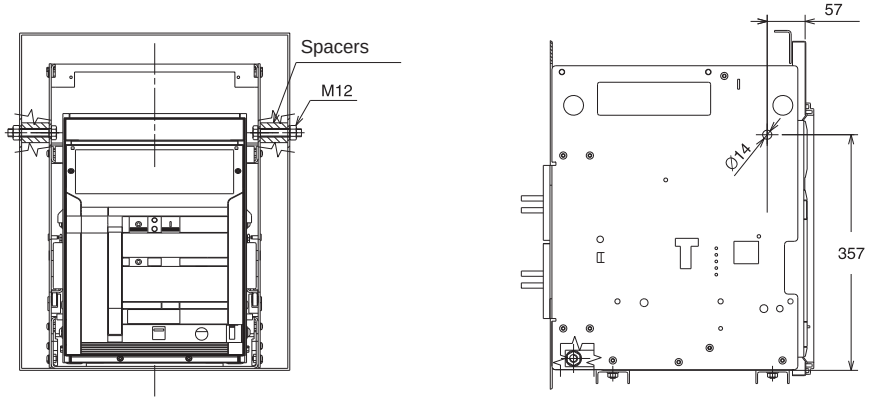
4.3.2. Installation of the fixed part (Fig. 12)

Attach the fixed part by means of the screws (1), washers (2) and nuts (3) (M8 x 16), supplied by ABB SACE. if other screws are used, make sure that the head of the screws does not extend more than 5.5 mm from the base of the fixed part.

4.3.3. Installation of the fixed part on board a ship (Fig. 11)

Regarding the fixing points of the SACE Emax withdrawable version air circuit-breakers, for applications on board a ship, additional fixing on the sides of the fixed part itself is recommended (the M12 screws and the spacers are not provided in the supply).

E1 - E2 - E3



E4 - E6

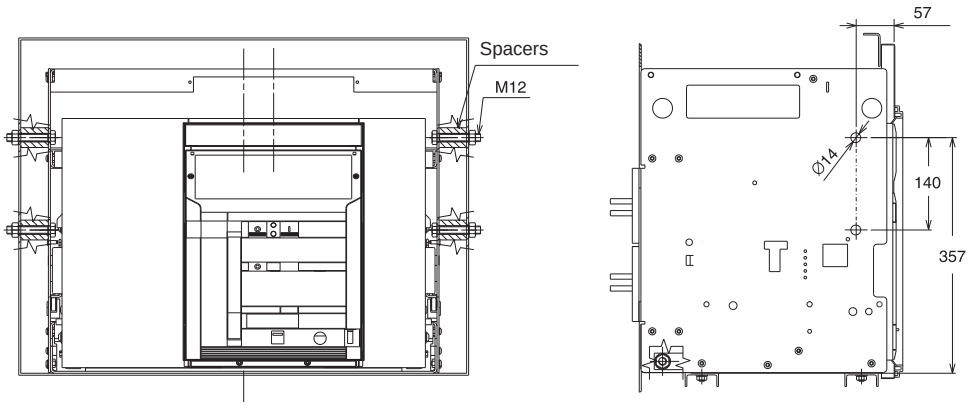
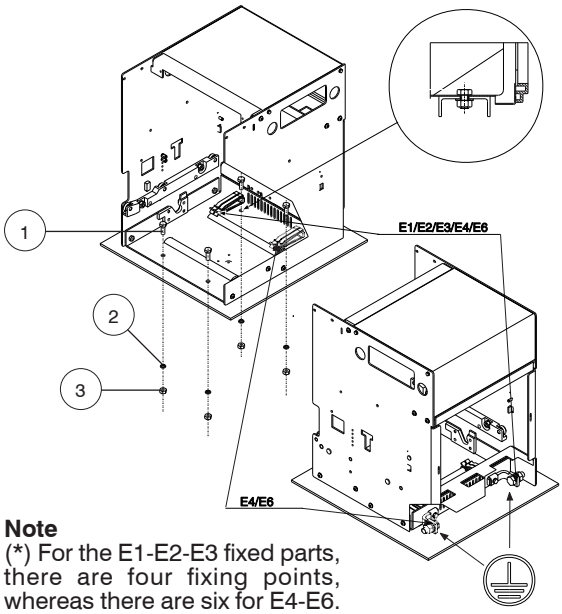


Fig. 11

4.4. Installation of the flange on the compartment door (Fig. 13)

- Make the compartment door drillings specified in the “Overall dimensions” paragraph.
- Attach the flange (1) on the front of the compartment door, fixing it from the inside by means of the self-tapping screws (2).



Note
(*) For the E1-E2-E3 fixed parts, there are four fixing points, whereas there are six for E4-E6.

Fig. 12

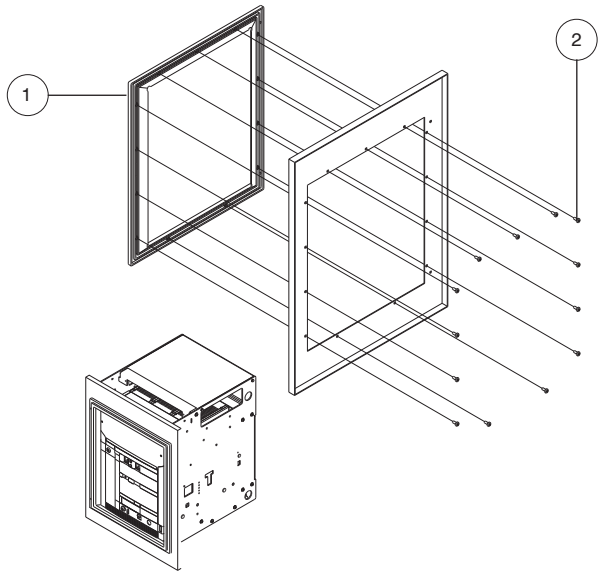


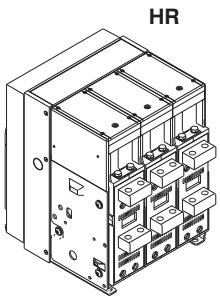
Fig. 13

5. Electrical connections

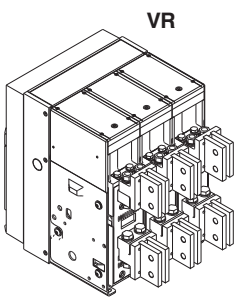
5.1. Connections to the power circuit

5.1.1. Shapes of the terminals

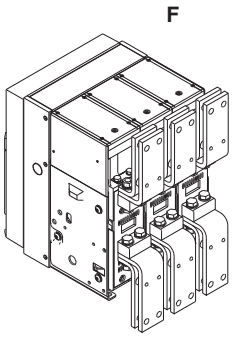
Fixed circuit-breaker



Horizontal rear terminals



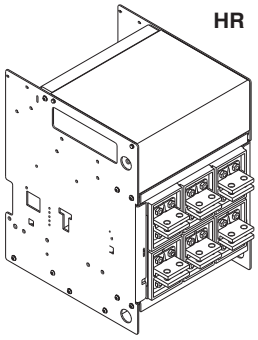
Vertical rear terminals



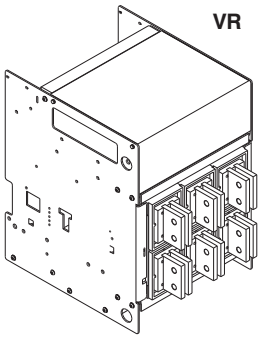
Front terminals

Fig. 14

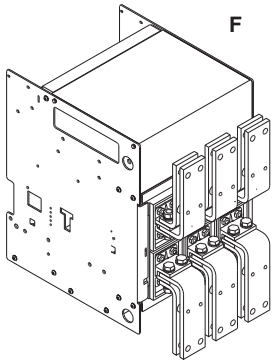
Fixed part for withdrawable circuit-breaker



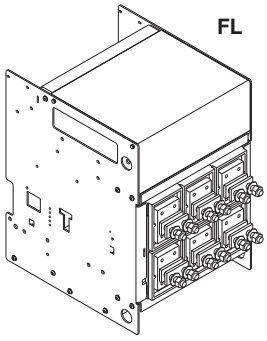
Horizontal rear terminals



Vertical rear terminals



Front terminals



Flat terminals

Fig. 15

Note
The drawings are provided to show the type of terminal in graphic form. The exact shape of the terminals is given in the “Overall dimensions” chapter.

5.1.2. Examples of positioning the connection busbars according to the types of terminals

The connection busbars enable the connection between the terminals of the circuit-breakers and the busbars of the switchgear. Their sizing must be carefully studied by the switchgear designer. Some examples of possible constructions in relation to the shape and size of the circuit-breaker terminals are given in this paragraph. The various types of terminals are of constant dimensions for each size of circuit-breaker: it is normally advisable to exploit the whole contact surface of the terminal, so the width of the connection busbars should be the same as that of the terminal. Different connection capacities can be obtained by adjusting the thickness and number of busbars in parallel. In some cases, reductions in the width of the connection in relation to that of the terminal are allowable as shown in the following examples.

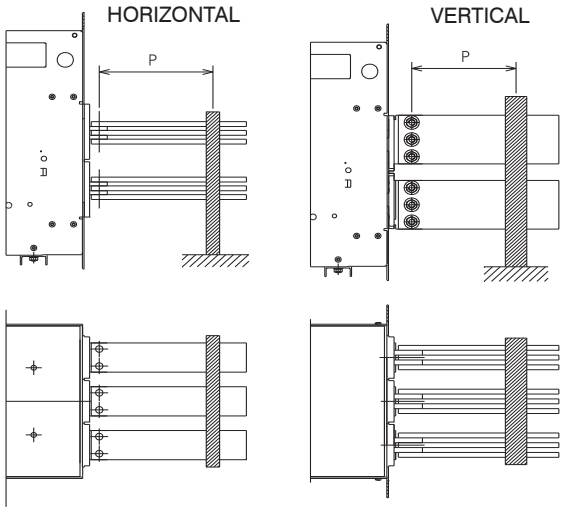
		Vertical terminals				**Horizontal and front terminalsi**			
Circuit-breaker	Iu [A]	Continuous current-carrying capacity [A]			Busbar cross-section [mm²]	Continuous current-carrying capacity [A]			Busbar cross-section [mm²]
		35°C	45°C	55°C		35°C	45°C	55°C	
E1B/N 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E1B/N 10	1000	1000	1000	1000	1x(80x10)	1000	1000	1000	2x(60x8)
E1B/N 12	1250	1250	1250	1250	1x(80x10)	1250	1250	1200	2x(60x8)
E1B/N 16	1600	1600	1600	1500	2x(60x10)	1550	1450	1350	2x(60x10)
E2S 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E2N/S 10	1000	1000	1000	1000	1x(60x10)	1000	1000	1000	1x(60x10)
E2N/S 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2B/N/S 16	1600	1600	1600	1600	2x(60x10)	1600	1600	1530	2x(60x10)
E2B/N/S 20	2000	2000	2000	1800	3x(60x10)	2000	2000	1750	3x(60x10)
E2L 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2L 16	1600	1600	1600	1500	2x(60x10)	1600	1500	1400	2x(60x10)
E3H/V 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E3S/H 10	1000	1000	1000	1000	1x(60x10)	1000	1000	1000	1x(60x10)
E3S/H/V 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E3S/H/V 16	1600	1600	1600	1600	1x(100x10)	1600	1600	1600	1x(100x10)

Circuit-breaker	Iu [A]	Vertical terminals				Horizontal and front terminalsi			
		Continuous current-carrying capacity [A]			Busbar cross-section [mm²]	Continuous current-carrying capacity [A]			Busbar cross-section [mm²]
		35°C	45°C	55°C		35°C	45°C	55°C	
E3S/H/V 20	2000	2000	2000	2000	2x(100x10)	2000	2000	2000	2x(100x10)
E3N/S/H/V 25	2500	2500	2500	2500	2x(100x10)	2500	2450	2400	2x(100x10)
E3N/S/H/V 32	3200	3200	3100	2800	3x(100x10)	3000	2880	2650	3x(100x10)
E3L 20	2000	2000	2000	2000	2x(100x10)	2000	2000	1970	2x(100x10)
E3L 25	2500	2500	2390	2250	2x(100x10)	2375	2270	2100	2x(100x10)
E4H/V 32	3200	3200	3200	3200	3x(100x10)	3200	3150	3000	3x(100x10)
E4S/H/V 40	4000	4000	3980	3500	4x(100x10)	3600	3510	3150	6x(60x10)
E6V 32	3200	3200	3200	3200	3x(100x10)	3200	3200	3200	3x(100x10)
E6H/V 40	4000	4000	4000	4000	4x(100x10)	4000	4000	4000	4x(100x10)
E6H/V 50	5000	5000	4850	4600	6x(100x10)	4850	4510	4250	6x(100x10)
E6H/V 63	6300	6000	5700	5250	7x(100x10)	--	--	--	-

Fig. 16

Positioning the first anchoring baffle of the busbars according to the short-circuit current

Anchoring to the switchgear



P	E1-E2	E3-E4-E6	E1-E6
HORIZONTAL	250	150	–
VERTICAL	250	150	–
FRONT	–	–	250
FLAT	–	–	250

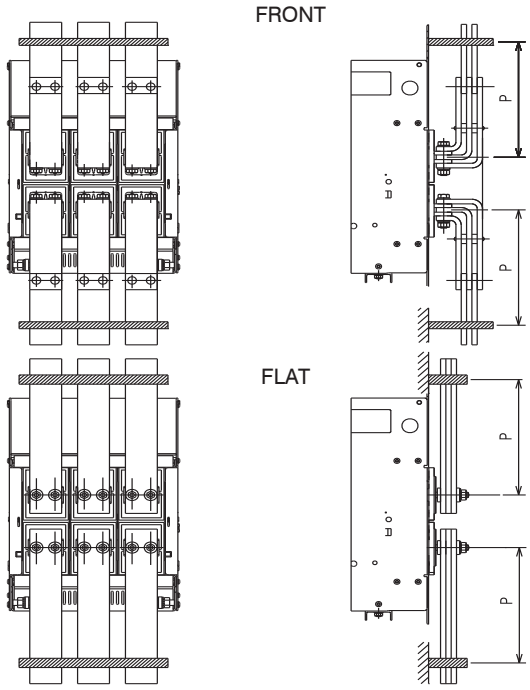


Fig. 17

5.1.3. Assembly procedure for the connection busbars

Check the state of the contact surfaces of the connections very carefully: they must be very clean with no burrs, dents or traces of rust which must be eliminated using a fine file or an emery cloth to prevent localized increases in temperature. On completion of the operation, remove all traces of grease or dust with a cloth soaked in a suitable solvent. When alluminium connections the contact surfaces must be tinned.
The connections must not exert any strain on the terminals in any direction.
Always insert a large-diameter flat washer and a spring washer between them (to spread the tightening pressure over a greater area).
Make the contact between connection and terminal and tighten the fixing screws completely.
Always use two wrenches (so as not to strain the insulating parts excessively), applying the tightening torque indicated in Fig. 18. Check tightness after 24 hours.

M12 high strength screws
Tightening torque of the main terminals: 70 Nm

Fixed part terminals	No. of screws for phase	No. of screws for neutral
E1/E2	2	2
E3	3	3
E4	4	2
E4/f	4	4
E6	6	3
E6/f	6	6

Fixed circuit-breaker terminals	No. of screws for phase	No. of screws for neutral
E1/E2	2	2
E3	3	3
E4	4	2
E4/f	4	4
E6	6	3
E6/f	6	6

Fig. 18

5.2. Earthing

The fixed circuit-breaker and the fixed part of the withdrawable circuit-breaker have one or two terminals on the rear, marked with the special symbol, for connection to earth (Fig. 9 and Fig. 12).
Each terminal is complete with a bolt for fixing the connection. A conductor with a cross-section conforming to current standards must be used for the connection.
Before assembling the connection, clean and degrease the area around the screw.
After the assembly, tighten the bolt with a torque of 70 Nm.

5.3. Wiring the circuit-breaker auxiliary circuits

5.3.1. Interfacing elements for fixed circuit-breakers

A special terminal box is provided, fitted with screw terminals for connecting the auxiliary circuits.
The terminals are marked with alphanumerical identification codes as for the electrical circuit diagram.
The terminal box is identified by code XV on the electrical circuit diagram.
The terminal box is immediately accessible when the compartment door is open.

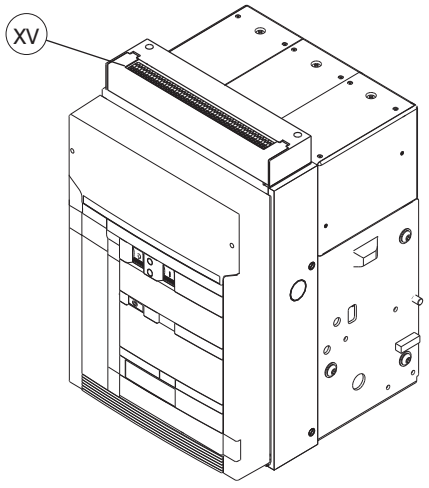
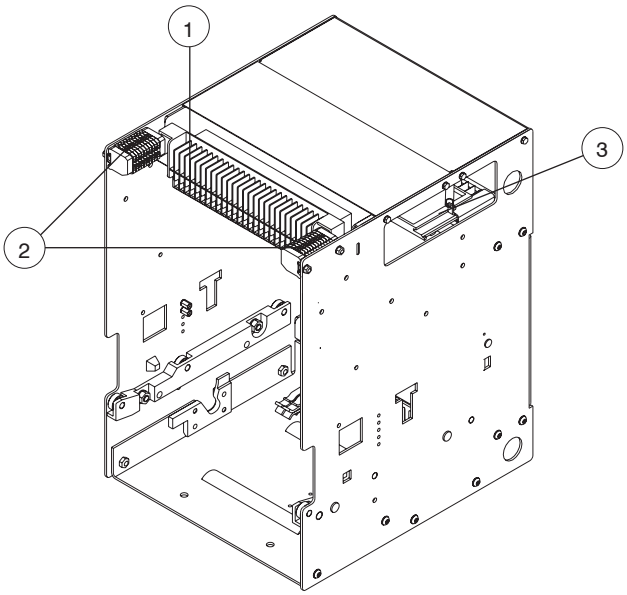


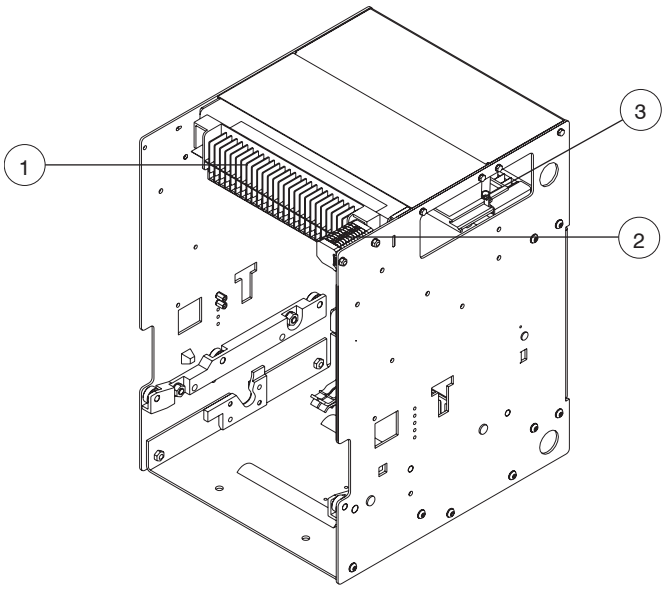
Fig. 19

5.3.2. Withdrawable circuit-breaker

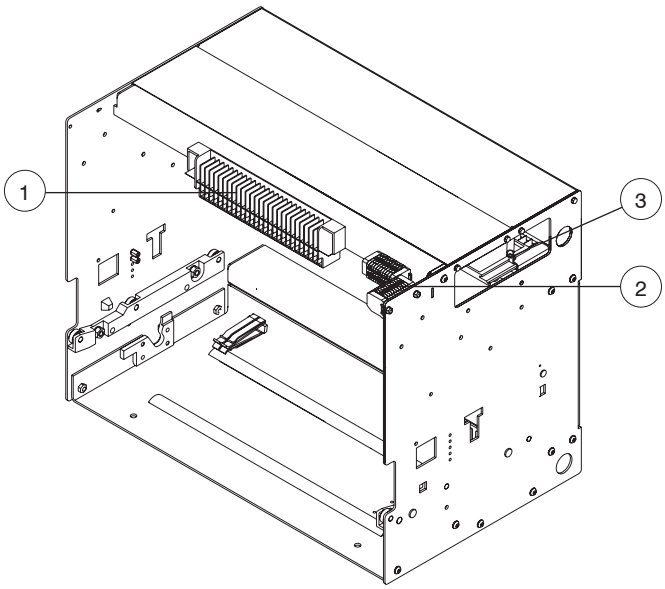
For connection of the moving part to the auxiliary circuits, a connection with sliding contacts is available on the fixed part (see figure), identified by code X on the electrical circuit diagram.
The terminals of the fixed connector are immediately accessible when the compartment door is open.
Furthermore a terminal box identified by code XF is available for connecting the position contacts of the moving part in relation to the fixed part.
The connector and terminal box have screw terminals.



E1 - E2 - E3
10 contacts in position



E1 - E2 - E3 - E4 - E6
5 contacts in position



E4 - E6
10 contacts in position

Caption

1 Sliding contacts (X)
2 Terminal box for position contacts (XF)
3 Position contacts

Fig. 20

5.4. Conversion of the auxiliary contacts or of the signalling contacts (disconnected - test isolated - connected), from normally closed (opening) to normally open (closing) or vice versa

The contacts are wired at the factory as shown on the electrical circuit diagram. If it is necessary to change their state for installation requirements, proceed as follows.

a) Auxiliary contacts
To access the auxiliary contacts, carry out the following operations:

- remove the front protection (3) of the release by taking action on the blocks (1) as shown in the figure
- remove the protection release (4) removing the side nuts (2) and then sliding the release out from the front of the circuit-breaker.

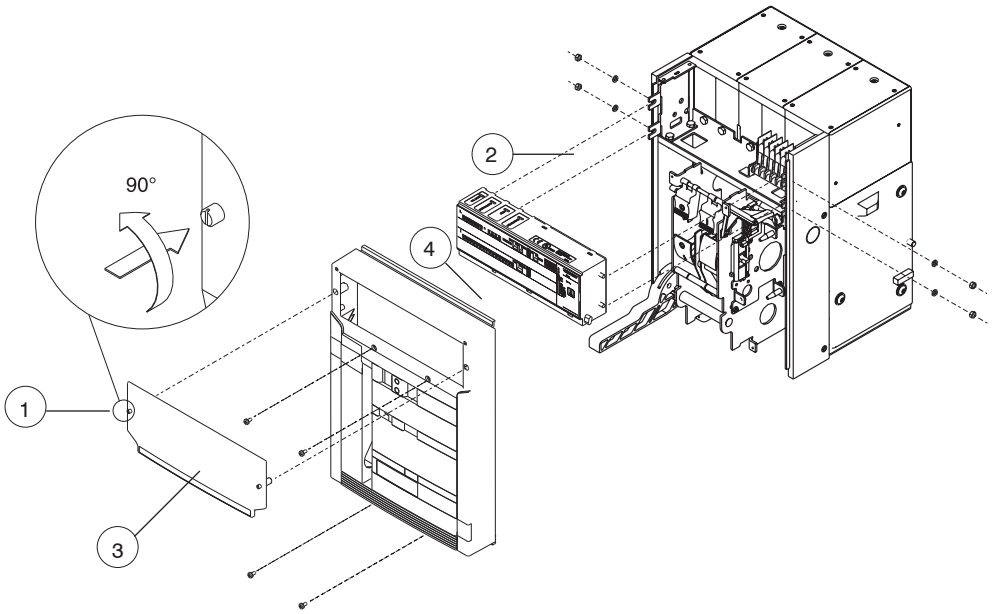
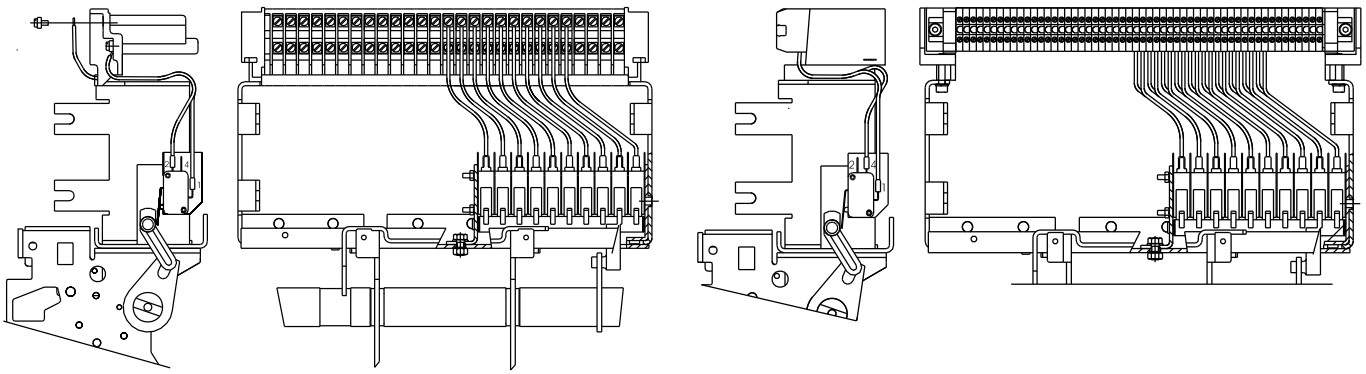


Fig. 21

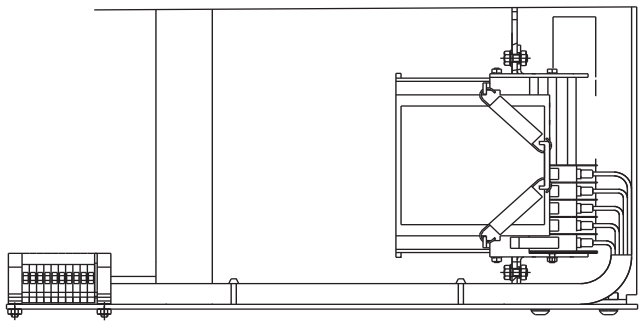
Being of the two-way type (changeover contacts), the auxiliary contacts can be modified from break contacts to make contacts and vice versa simply by moving the output conductor from one position to the other, as shown in the figure (example for PR121).



N.C. contact | Sliding contacts | N.O. contact | Terminal box

Fig. 22

b) Signalling contacts disconnected - test isolated - connected
To change the state of the position contact, proceed in the same way as explained for the auxiliary contacts.



6. Putting into service

6.1. General procedures

- Check tightness of the power connections at the circuit-breaker terminals
- Carry out all the preparatory operations on the release
- Make sure that the value of the auxiliary circuit power supply voltage is between 85 and 110% of the rated voltage of the electrical applications
- Make sure that there is an adequate air circulation in the place of installation to avoid overheating
- Also carry out the checks specified in the following table.

	Item inspected	Procedure	Positive check
1	Manual operating mechanism	Carry out some opening and closing operations (see the chapter 7.2). **CAUTION** **When there is an undervoltage release, the circuit-breaker can only be closed after the release has been electrically energized.**	The spring loading lever moves correctly
2	Geared motor (if any)	Supply the spring loading geared motor at the corresponding rated voltage. Carry out some closing and opening operations. Note. Supply the undervoltage release at the corresponding rated voltage (if any).	The springs are loaded correctly. The signals are correct. The geared motor stops with the springs loaded. The geared motor reloads the springs after each closing operation.
3	Undervoltage release (if any)	Supply the undervoltage release at the corresponding rated voltage and carry out the circuit-breaker closing operation. Disconnect voltage to the release. Supply the undervoltage release at the corresponding rated voltage and carry out the circuit-breaker closing operation.	The circuit-breaker closes correctly. The signals are correct. The circuit-breaker opens. The signal changes over..
4	Shunt opening release (if any)	Close the circuit-breaker. Supply the shunt opening release at the corresponding rated voltage.	The circuit-breaker opens correctly. The signals are correct..
5	Shunt closing release (if any)	Open the circuit-breaker. Loading the springs. Supply the shunt closing release at its rated voltage.	The circuit-breaker closes correctly. The signals are correct.
6	Circuit-breaker lock in the open position (with key or padlocks)	Open the circuit-breaker, turn the key and remove it from its seat. Attempt circuit-breaker closing operation.	Both manual and electrical closing are prevented.
7	Auxiliary contacts of the circuit-breaker	Insert the auxiliary contacts in suitable signalling circuits. Carry out some circuit-breaker closing and opening operations.	The signals are given correctly..
8	Auxiliary contacts for signalling circuit-breaker connected, test isolated and disconnected	Insert the auxiliary contacts in suitable signalling circuits. Then put the circuit-breaker in the connected, test isolated and disconnected position.	The signals due to the relative operations are given correctly..
9	Lock devices for circuit-breakers connected and disconnected. Interlocking devices between circuit-breakers side by side and one on top of another (if any)	Carry out the operating tests.	The locks function correctly.
10	For withdrawable circuit-breakers: racking -in/out device	Carry out some racking-in and out operations.	Racking-in operation: the circuit-breaker racks in correctly. The first turns of the crank handle do not meet with particular resistance.

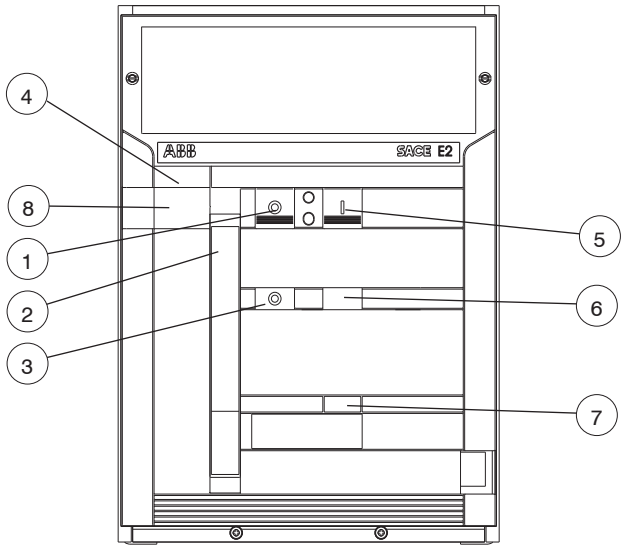
WARNING: When undervoltage release has been activated by an undervoltage event, the circuit-breaker can only be closed after the release has been electrically energized. Ensure that an undervoltage condition existed at the time the release was activated. If not, investigate circuit-breaker and associated equipment to ensure they are in proper working order. If application is critical, investigate immediately.

7. Instructions for use

7.1. Operating and signalling parts

1 Pushbutton for the manual opening operation
2 Lever for manual loading of the closing springs
3 Mechanical indicator for circuit-breaker open “O” and closed “I”
4 Mechanical indicator for protection release tripped (on request)
5 Pushbutton for the manual closing operation
6 Signalling device for springs loaded - unloaded
7 Operation counter (on request)
8 Key lock on the closing operation
9 Mechanical indicator for circuit-breaker connected, test isolated and disconnected
10 Seat for the racking-in/out lever
11 Lever releasing the racking-in/out operation
12 Key lock on the racking-in/out operation (on request)
13 Padlock on the manual closing operation (on request)
14 Padlock on the racking-in/out operation (on request)

Fixed circuit-breaker



Withdrawable circuit-breaker

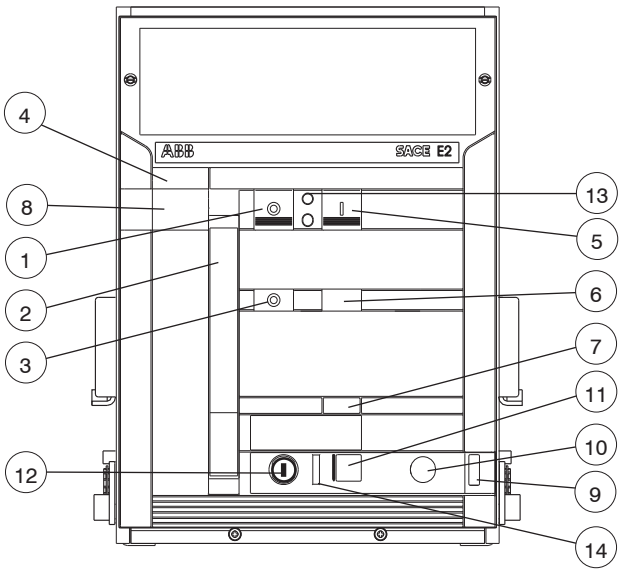


Fig. 23

Note On request, a transparent cover can be installed on the front of the circuit-breaker to increase the degree of protection to IP54. The cover has a locking key.
As an alternative to the transparent cover, a protection can be mounted on the manual closing and opening controls, which only allows operation of the pushbuttons by means of a special tool..

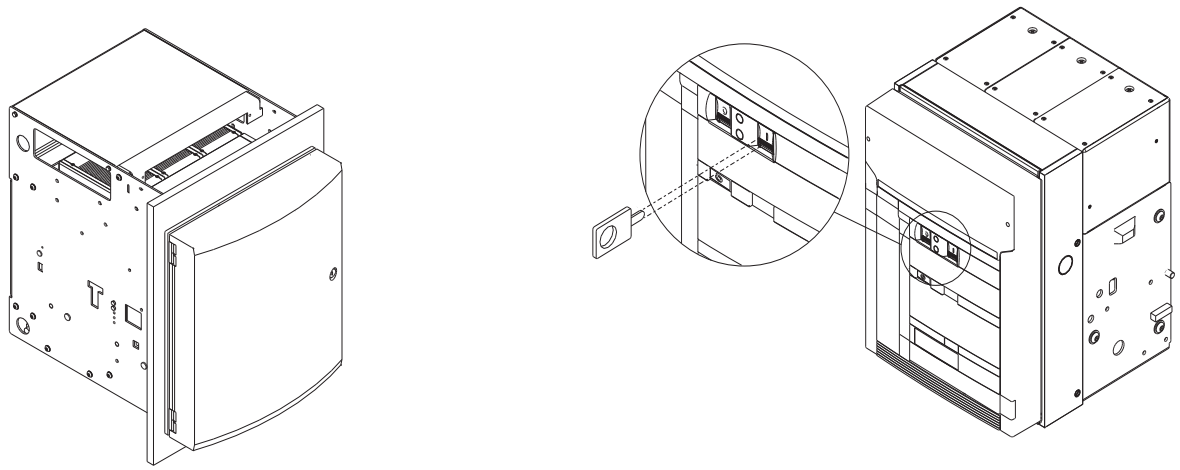


Fig. 24

7.2. Circuit-breaker closing and opening procedures

The operation of the circuit-breaker can be either manual or electrical.

a) Manual loading of the closing springs

- Make sure that the indicator (3) shows “O” (circuit-breaker open)
- Make sure that the indicator (6) is WHITE (springs unloaded)
- Repeatedly activate the lever (2) until the indicator (6) changes its color to YELLOW

b) Electrical loading of the closing springs

The electrical loading of the circuit-breaker is possible when the following accessories (supplied on request) are present:
– geared motor for automatic loading of the closing springs
– shunt closing release
– shunt opening release.
The geared motor automatically reloads the springs after each closing operation until the yellow indicator appears (6, Fig. 25). When the power is cut off during loading, the geared motor stops and automatically starts reloading the springs again when the power returns. It is, in any case, always possible to complete the reloading operation manually.

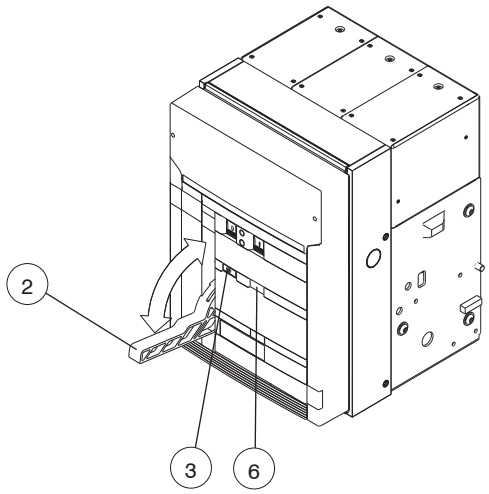


Fig. 25

c) Closing the circuit-breaker

The operation can only be carried out with the closing springs fully loaded. For manual closing, press the pushbutton (5) marked with the letter “I”. When there is a shunt closing release, the operation can be carried out remotely by means of the special control circuit. The special indicator (3) changes to indicate “I” to signal that the circuit-breaker has closed. Furthermore, the indicator of the state of the springs (6) goes to the WHITE position. Even with the closing springs unloaded, the operating mechanism retains enough energy for the opening operation. The geared motor, if any, immediately starts the automatic spring reloading operation.

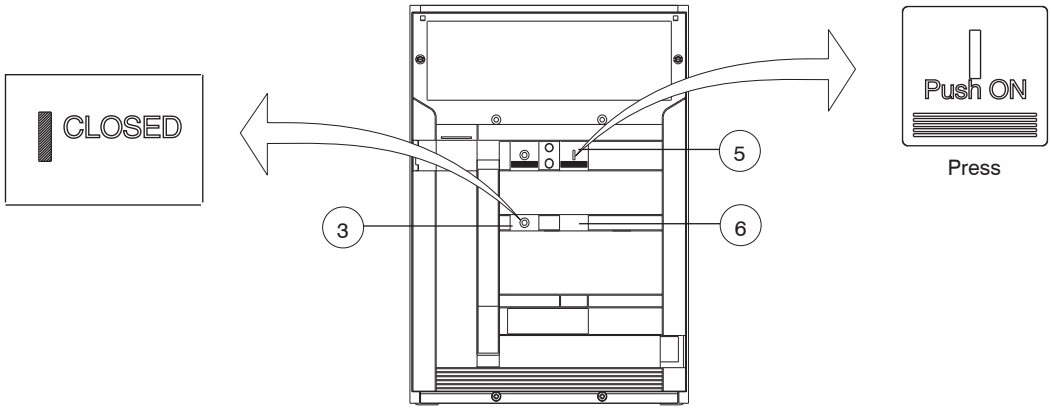


Fig. 26

d) Opening the circuit-breaker

For manual opening of the circuit-breaker, press pushbutton “O” (1). When there is a shunt opening release, the operation can also be carried out remotely by means of the special control circuit. Opening having taken place is signaled by the letter “O” appearing in the indicator (3).

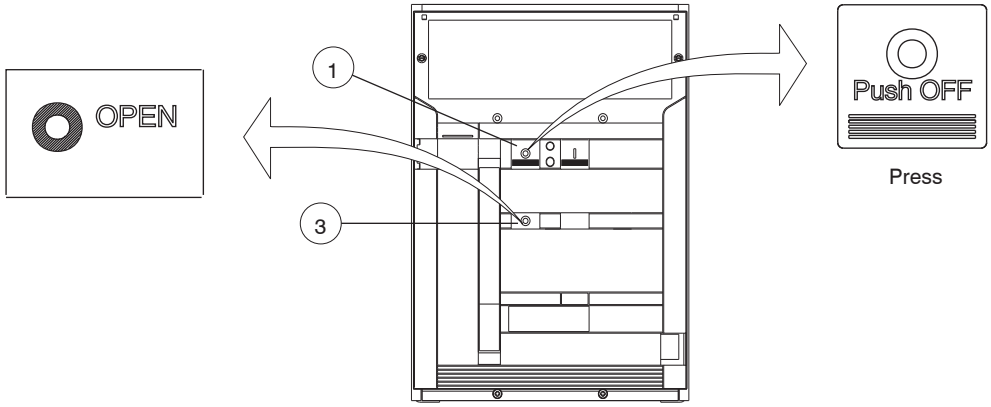


Fig. 27

7.3. Racking-in/out operation

WARNING

A) Open the circuit-breaker before carrying out any racking-in/out operation.
B) The circuit-breaker (moving part) and fixed part are fitted with a lock which prevents the fixed part from being racked into the circuit-breakers with a different rated current: the congruence of the anti-racking-in lock must be checked by the operator before carrying out the racking-in operation to avoid any unnecessary stress.
C) Before the racking-in operation, remove any padlock on the segregation shutter of the isolation terminals on the fixed part.

WARNING ELECTRICAL SHOCK HAZARD: Ensure that the circuit-breaker is either disconnected from all power sources and that the circuit breaker is open before performing any racking-in/out operation.

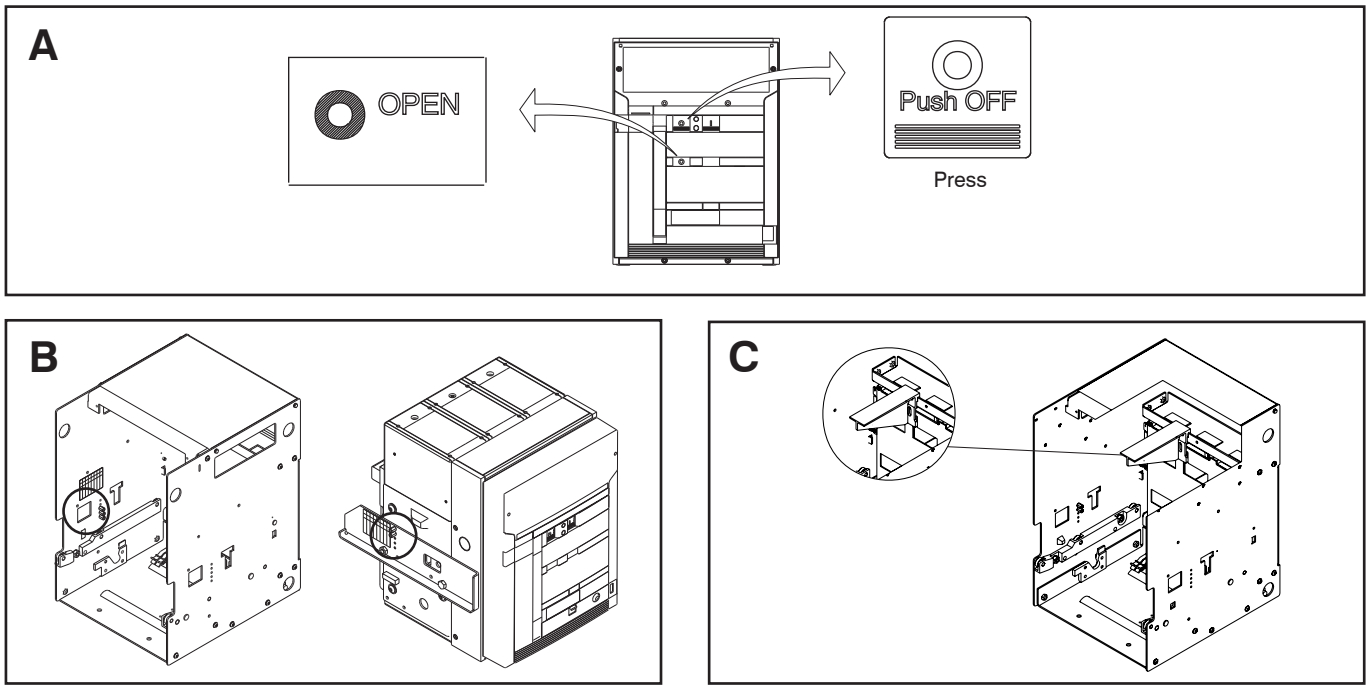


Fig. 28

NOTE

In relation to the fixed part, the circuit-breaker (moving part) can take up different positions, identified as follows:

- DISCONNECTED: the moving part is inserted in the fixed part WITHOUT any connection between the power terminals and WITHOUT coupling the sliding contacts for the auxiliary circuits: in this position all electrical operation of the circuit-breaker is prevented. On the front the indicator (9, Fig. 23) indicates DISCONNECTED. The switchgear compartment door can be closed.
- TEST ISOLATED: the moving part is inserted in the fixed part WITHOUT any connection between the power terminals, but WITH the sliding contacts coupled for the auxiliary circuits. In this position, the circuit-breaker can be operated for the offline tests. The indicator (9, Fig. 23) indicates TEST ISOLATED.
- CONNECTED: the moving part is fully inserted in the fixed part WITH the connection of both the power terminals and the sliding contacts for the auxiliary circuits. The circuit-breaker is operational. The indicator (9, Fig. 23) indicates CONNECTED.

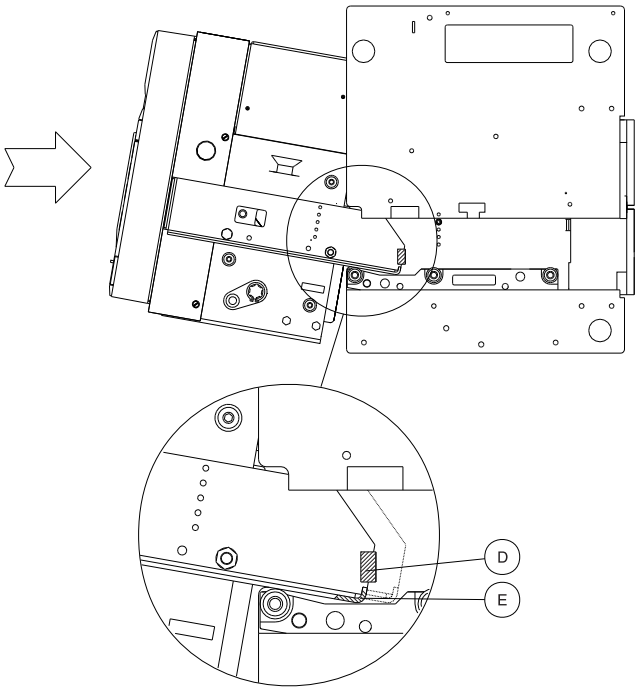


Fig. 29

a) Positioning the moving part in the fixed part in the DISCONNECTED position
Lift the moving part as shown in the paragraph (3) and insert it in the fixed part guide, tilting it as shown in figure 2.
The manual connection must allow the edge (E) of the circuit-breaker guide to slide under the blocks (D) of the fixed part. Remove the lifting devices.
The position reached is stable and allows for any inspections of the circuit-breaker.
Push the moving part as far as the stop in the fixed part.
Close the compartment door.

b) Passing from the DISCONNECTED to the TEST ISOLATED position.
- Make sure that the indicator (9) is in the DISCONNECTED position.
- For the connection procedure, make sure that the key (12) is in the correct position and/or the padlock (14), if any, has been removed.
- Make sure that the circuit-breaker is open.
- Push the moving part right into the fixed part.
- Lower the releasing lever (11).
- Insert the crank handle in the corresponding coupling (10).
- Proceed to turn the crank handle clockwise until the TEST ISOLATED indication appears on the indicator (9). During the initial turns, the crank handle must oppose no any particular resistance to rotation.
- Should it be necessary to carry out offline circuit-breaker operations, the crank handle must be removed.

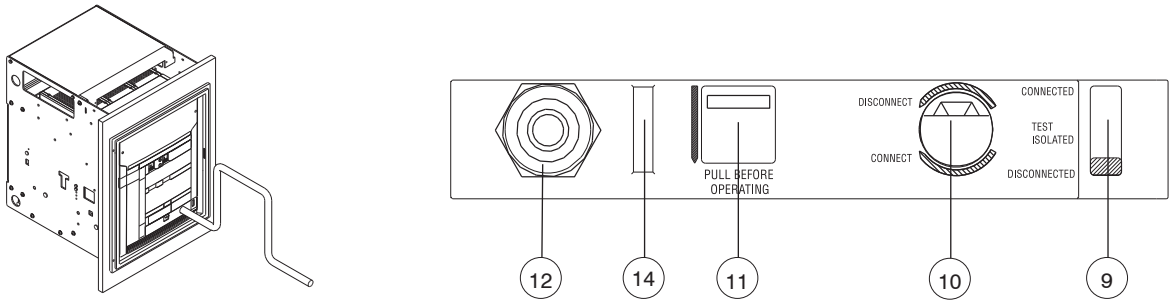


Fig. 30

c) Passing from the TEST ISOLATED position to the CONNECTED position
- Make sure that the circuit-breaker is open.
- Lower the releasing lever (11).
- Insert the crank handle in the corresponding coupling (10).
- Proceed to turn the crank handle clockwise until the CONNECTED indication appears on the indicator (9).
- Remove the crank handle to enable the circuit-breaker to close.

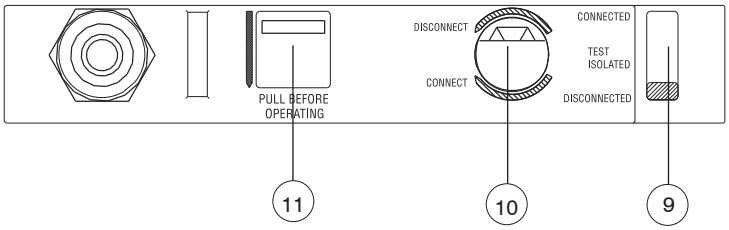


Fig. 31

d) Passing from the CONNECTED position, to the TEST ISOLATED position, to the DISCONNECTED position
- Repeat the connection procedures changing the direction for turning the crank handle to anti-clockwise. Open the door in the disconnected position.

8. Maintenance

8.1. Warning

WARNING: Before carrying out any maintenance task, you must:
- **Open the circuit-breaker and check that the operating mechanism springs are unloaded;**
- **In the case of withdrawable circuit-breakers, work with the circuit-breaker racked-out (DISCONNECTED) of the fixed part;**
- **For action on fixed version circuit-breakers or on fixed parts disconnect the power circuit and the auxiliary circuits and visibly earth the terminals both on the power supply side and on the load side;**
- **Make safe in compliance with current laws.**

WARNING ELECTRICAL SHOCK HAZARD: Shock Hazard or Injury.

ABB declines all responsibility for damage to things and injury to people due to failure to comply with the instructions contained in this document. Maintenance tasks must be performed by qualified staff who are thoroughly familiar with the equipment.

8.2. Maintenance programme

8.2.1. Switch life

With regular maintenance, SACE Emax circuit-breakers, either with or without opening or closing releases, can withstand the following operation without replacement of parts. (1)

Rated uninterrupted current		Mechanical life (2)		Electrical life (2)		
Iu (40 °C) [A]		No. of operations x 1000	Frequency operations/hour	440 V ~ No. of operations x 1000	690 V ~ No. of operations x 1000	Free operations/hour
E1 B-N	800	25	60	10	10	30
	1000-1250	25	60	10	8	30
	1600	25	60	10	8	30
E2 B-N-S	800	25	60	15	15	30
	1000-1250	25	60	15	15	30
	1600	25	60	12	10	30
	2000	25	60	10	8	30
E2 L	1250	20	60	4	3	20
	1600	20	60	3	2	20
E3 N-S-H-V	800	20	60	12	12	20
	1000-1250	20	60	12	12	20
	1600	20	60	10	10	20
	2000	20	60	9	9	20
	2500	20	60	8	7	20
	3200	20	60	6	5	20
E3 L	2000	15	60	2	1,5	20
	2500	15	60	1,8	1,3	20
E4 S-H-V	3200	15	60	7	7	10
	4000	15	60	5	4	10
E6 H-V	3200	12	60	5	5	10
	4000	12	60	4	4	10
	5000	12	60	3	2	10
	6300	12	60	2	1,5	10

(1) Data referring to standard installation conforming to product standards. For other applications, consult ABB Sace.
(2) Extreme atmospheric conditions, polluted atmosphere or vibrations may shorten the application's life. Consult ABB Sace.

8.2.2. Maintenance program

The table shows the maintenance intervals and the frequency of periodical intervention and routine maintenance tasks. The following rules should also be followed:

- Even circuit-breakers that are little used or remain on or off for long periods should be subject to the maintenance programme.
- For circuit breakers fitted with SACE PR121 installation of the mechanical operation counter (supplied on request) is recommended; the SACE PR122 and SACE PR123 releases with Vaux enable the number of operations performed by the circuit breaker in use to be displayed at any moment on the display.
- During operation, inspect the switch from the outside to check for dust, dirt or damage of any kind.

Maintenance operations	Interval	
	Installation in normal environments	Installation in dusty environments (1)/(2) [(1) = level of measured dust > 1 mg/m³]
First level	One year or 20% mechanical life or 20% electric life	6 months or 10% mechanical life or 10% electric life
Second level	Three years or 50% mechanical life or 50% electric life or after intervention on short circuit	18 months or 25% mechanical life or 25% electric life or after intervention on short circuit

(1) Data referring to standard installation in accordance with product standards. For other applications, consult ABB Sace.
(2) Extreme atmospheric conditions, polluted atmosphere or vibrations may shorten the life of the application. Consult ABB Sace.

8.3. First level maintenance operations

8.3.1. Preliminary operations:

- open the switch and check that the control springs are unloaded
- in the case of a circuit-breaker, work on the circuit breaker after it has been extracted (disconnected) from the fixed part

WARNING: before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

8.3.2. Checks and general cleaning:

- Check that the apparatus (switching part) is clean, removing dust and any traces of excess oil or grease using dry and clean rags (possibly using non-corrosive detergent.
- For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Check that the rating plates of the apparatus are in place.
- Clean the rating plates with dry and clean cloths.
- Eliminate any dust, mould, traces of condensation or oxidation also inside the fixed part of the apparatus if the switch is extractable.
- Check that there are no foreign bodies in the switch cabinet.

8.3.3. Switch connections and connections between the switch and the control panel

- Use brushes and dry cloths to remove any dust or dirt (if necessary, use non-corrosive detergent.
- For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Check that there are no traces of overheating on the terminals. This problem is due to discolouring of the contact parts; the contact parts are normally silver in colour.
- Check that the bolts fixing the connections to the terminals are tight (M12 - 70Nm).

WARNING: before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

- Check that the connecting screws of the cables of the terminal boards are tight (0.7 Nm).

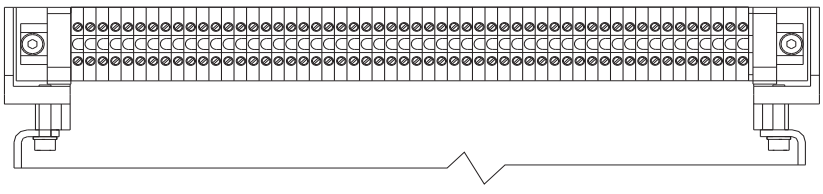


Fig. 32

8.3.4. Dismantling tab and cap

- The tab (1) of the release by rotating the screws (2) as shown in figure 33.
- Remove the front cap (3) by loosening the four screws (4).

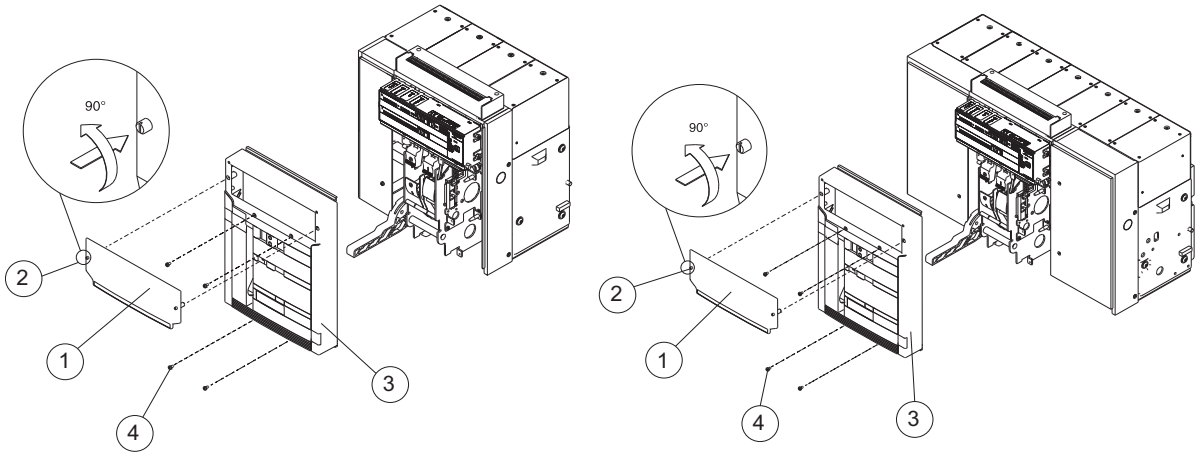


Fig. 33

- If there is a minimum release, remove the coils support and release the control springs, closing and opening the switch.

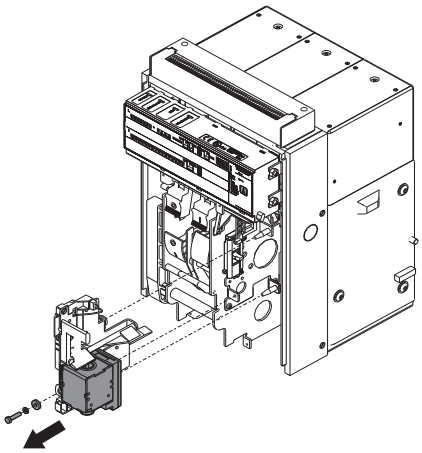


Fig. 34

8.3.5. Mechanical control

- Clean at the points indicated in figure 35. For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Lubricate, at the points indicated in fig. 35, the opening-closing shafts and hooks with MOBILGREASE 28 (EXXON MOBIL).
- Check that the opening and closing shafts are free to rotate.

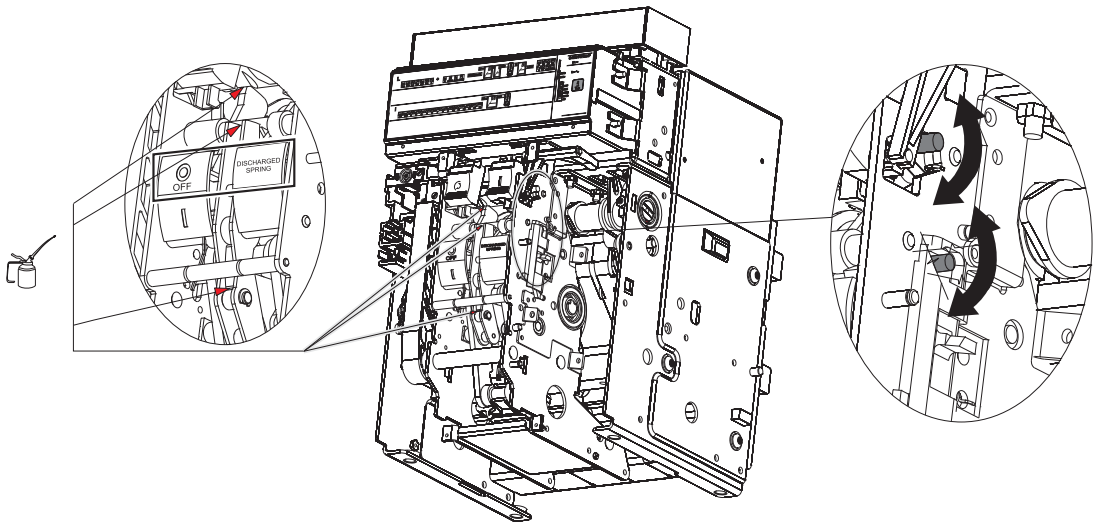


Fig. 35

8.3.6. Electrical and mechanical accessories

- Check that the accessories are fixed to the switch
- Check that the electrical accessories are connected to the switch
- Reduction gear: after 10000 operations check brushes for wear and replace the reduction gear if necessary.
- Check that the releases (SOR-UVR-SRC) are in good condition (no excessive wear, overheating, breakages) Fig. 36.
- Check that the mechanical operation counter is operating correctly (if applicable) by running an operation on the switch.

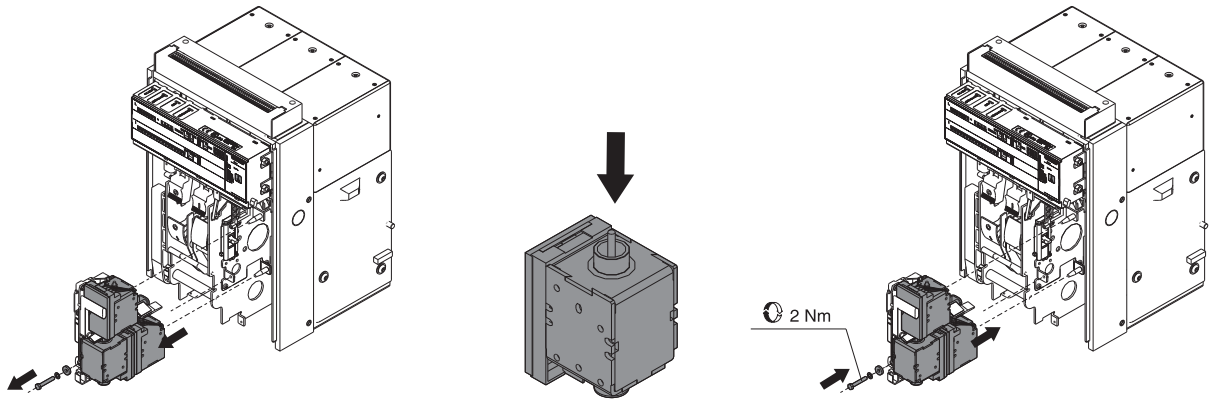


Fig. 36

8.3.7. Protection releases

- Supply the protection release from a PR030/B battery unit.
- Check that the protection release is working correctly: run “Trip Test” (PR121, PR122, PR123) and “Autotest” (PR122, PR123) for release.
- Use release PR122 or PR123 to check that there are no alarms on the display and via front LEDs.
- Use release PR121 to check that there are no alarms via front LEDs.
- Check that the cables are correctly connected to the release modules and to the release (if applicable).
- On PR122 and PR123 check the wear percentage to the switch contacts.
- At the end, remove the battery unit PR030/B from the relay.

8.3.8. Test with SD Testbus2 (optional)

- Connect unit BT030 or BT030-USB to the relay to be tested.
- Run the programme SD.TestBus2 on a PC with a Bluetooth or USB connection, depending on the version of BT030 used.
- Once the connection between the relay and PC has been installed, check that there are no alarm signals from the relay; otherwise, consult the paragraphs ‘Error Messages’ and/or ‘Troubleshooting’ in this manual.
- In normal operating conditions the trip test and the autotest can be run (depending on the type of relay); for future checks, we advise inserting the current date in the User Data and/or Tag Name area. These data will be stored inside the relay.
- Remove the BT030 or BT030-USB from the relay.

8.3.9. Maintenance operations; final checks

- Refit all parts and if necessary reconnect the auxiliary supply.
- Refit the cap as indicated in figure 37.

- Return the movable part to the TEST-ISOLATED position.
- Use the different auxiliaries in turn to run the following 10 operations:
  - Opening (both local and remote as applicable)
  - Closing (both local and remote as applicable)
  - Release by trip test from the relay

- Check the operations according to this sequence:
  - Open - Springs unloaded
  - Open - Springs loaded
  - Closed - Springs unloaded
  - Closed - Springs loaded

  - Check operation of the accessories, if present
  - Check operation of reduction gear (if present)
  - Check operation of minimum voltage release (if present)
  - Check operation of opening release (if present)
  - Check operation of closing release (if present)
  - Check operation of auxiliary contacts of switch (if present)
  - Check operation of lock of switch in open position (with key or padlocks) (if present)

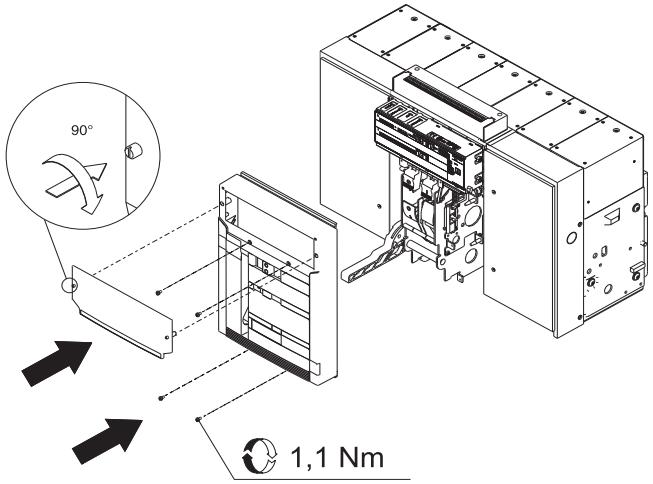


Fig. 37

8.3.10. Interlock

- Check that the interlock devices have been correctly installed and operate correctly between adjacent and superimposed switches (if present). The operating test cannot be run in the Test or Extracted positions.

8.4.1. Preliminary operations:

- open the switch and check that the control springs are unloaded
- in the case of a circuit breaker, remove the circuit breaker from the fixed part before working on it

WARNING: before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

8.4.2. General checks and cleaning:

- Check the cleanliness of the apparatus (switch part), removing dust and any traces of excess oil or grease with dry cloths (if necessary, use non-corrosive detergent)
- For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used.
- Check that the rating plates of the apparatus are in place
- Clean the rating plates with dry and clean cloths
- Eliminate any dust, mould, traces of condensation or oxidation also inside the fixed part of the apparatus if the switch is extractable
- Check that there are no factors such as overheating or cracks that may compromise switch insulation
- Check the circuit-breaking couple for damage (for the extractable switch, see feature A, fig 39).
- The couple must be silver in colour without trace of erosion or smoke
- Check that there are no foreign bodies in the switch cabinet
- Check that the fixing screws are tightened on the fixed side to the control panel (M8 - 25Nm).

8.4.3. Connections between the switch and the control panel

- Use brushes and try cloths to remove dust or dirt on the insulating parts (if necessary, use non-corrosive detergent - For excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used).
- Check that there are no traces of overheating on the terminals. The problem is detected by discoloration of the parts in contact; the contact points are normally silver in colour.
- Check the tightness of the bolts fixing the connections to the terminals (M12 - 70Nm).

WARNING:
Before working on fixed switches or switches on fixed parts, disconnect the supply to the power circuit and to the auxiliary circuits and earth the terminals in a visible manner both on the supply and on the load side.

- Check that the connecting screws of the cables of the terminal boards are tight (0.7 Nm).

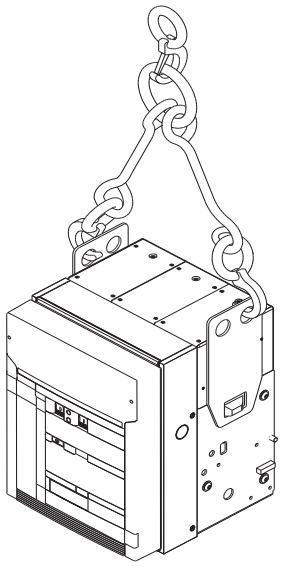


Fig. 38

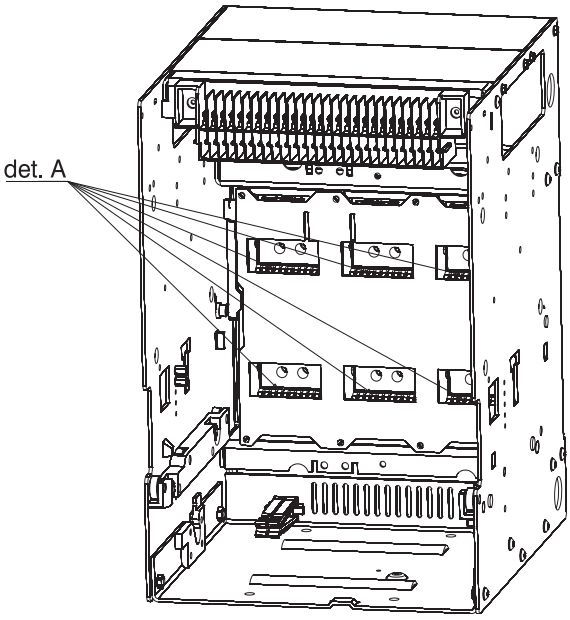


Fig. 39

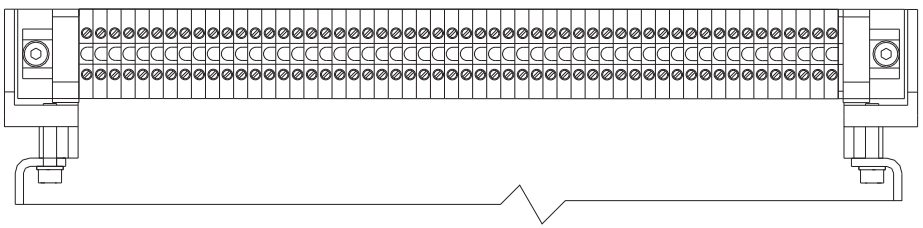


Fig. 40

8.4.4. Dismantling the tab, cap and arcing chambers

- Remove the flange (1) of the release, turning the screws (2) as shown in the figures
- Remove the front escutcheon plate (3) by removing the four screws (4)
- Remove, if present, one or both side guards (5) by removing the front (6) and lateral (7) screws
- Remove the arcing chambers (8) by removing the screws (9).

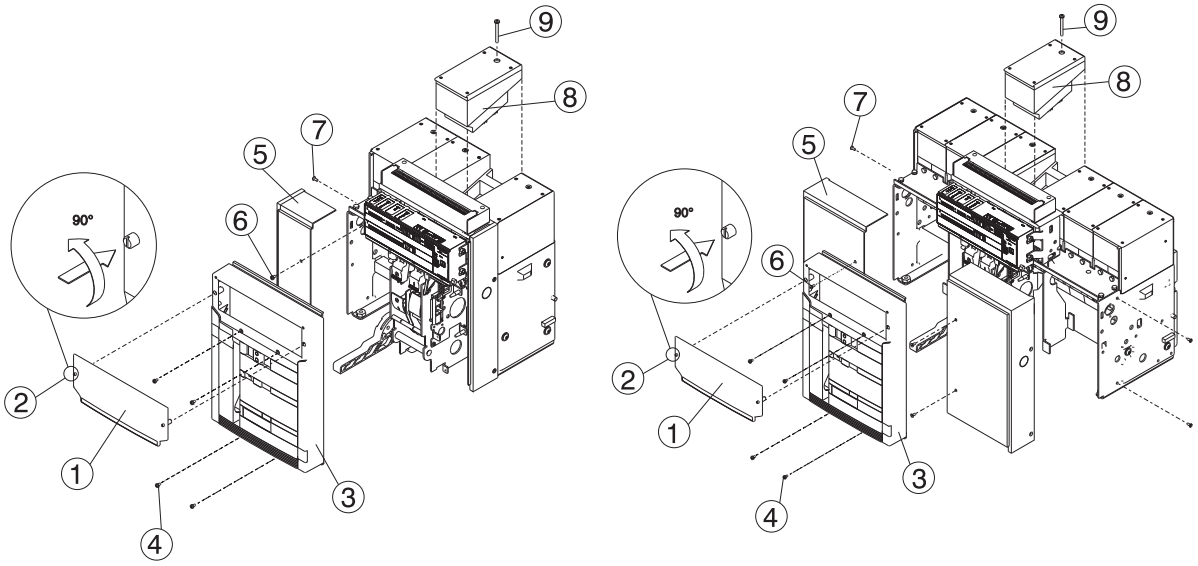


Fig. 41

- If there is a minimum release, dismantle the coil support and unload the control springs by opening and closing the switch.

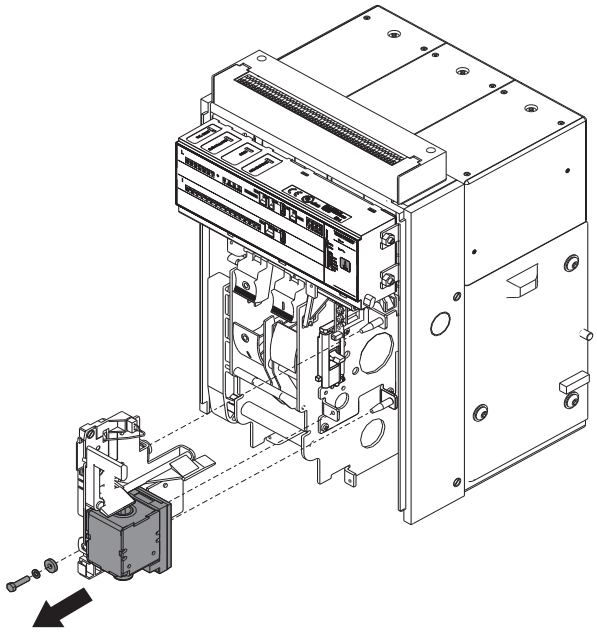


Fig. 42

8.4.5. Mechanical control

- Cleaning (for excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used) and lubricate, at the points indicated in fig. 43, part A, as for First Level, the opening and closing shafts and hooks with MOBILGREASE 28 (EXXON MOBIL).
- Cleaning (for excessive deposits, a laminated dilutant such as Henkel 273471 or the equivalent can be used) and lubricate with MOBILGREASE 28 (EXXON MOBIL) the supports of the operating shaft, including those on the sides of the switch (see fig. 43 part B).
- Check that the opening and closing shafts are free to rotate.

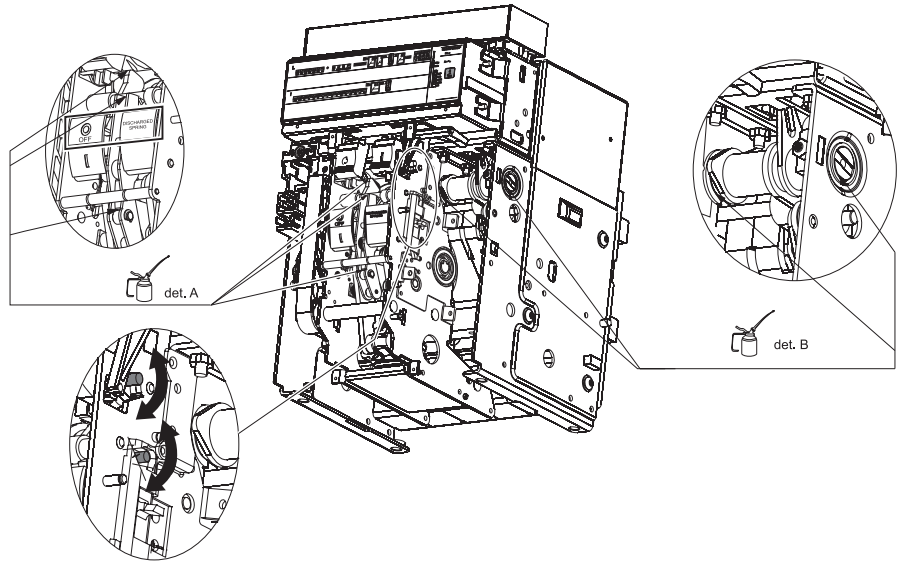


Fig. 43

- In the case of deformed or oxidated springs, missing rings or serious wear to the controls contact ABB Sace (*).

(*) Subject to the customer's approval, ABB can replace "A" type parts.

8.4.6. Electrical and mechanical accessories

- Check that the accessories are tightly fixed to the switch.
- Check that the electrical accessories are wired correctly to the switch.
- Reduction gear: after 10000 operations check brushes for wear and replace the reduction gear if necessary.
- Check that the releases (YO, YU, YC)) are in good condition (no excessive wear, overheating, breakages) fig 44.
- Check that the mechanical operation counter is operating correctly (if applicable) by running an operation on the switch.

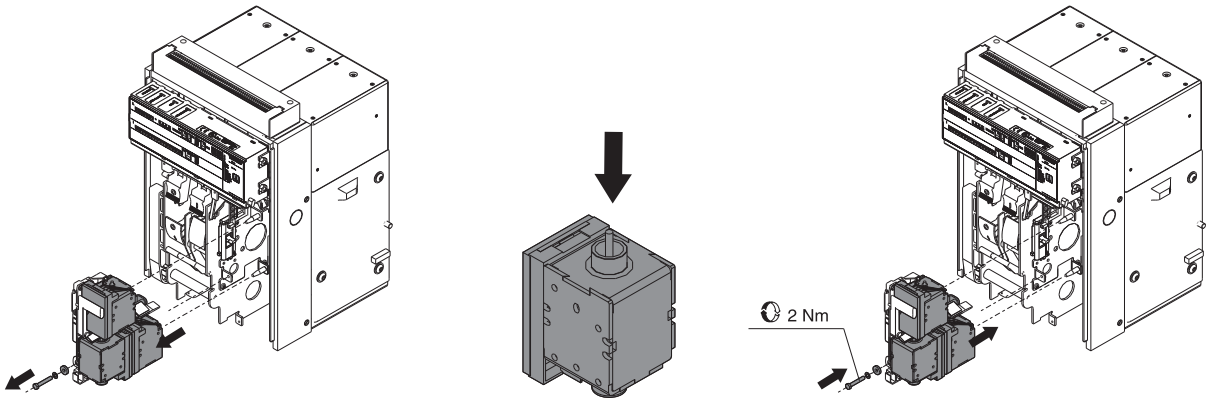


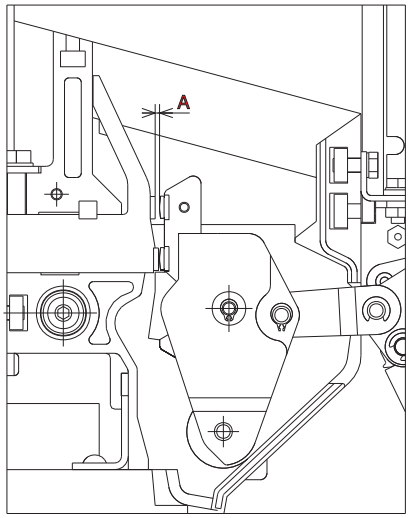
Fig. 44

8.4.7. Checking contact wear

With the switch open and arcing chambers removed:

1) Check the state of the blowout magnet chambers: the body of the chamber must be undamaged and the plates must not be corroded or damaged.
2) Remove the dust with compressed air and remove traces of smoke and any waste with a brush of appropriate type.
3) Check the state of the contacts.
4) Visually check that the main plates and the blowout magnets are in place.
5) Check for oxidation or beads and if they are detected, request help from the qualified ABB technician (*).

6.1) Check the blowout magnets distances (distance A fig 45).



Circuit Breaker	A
E1 - E2 - E3	≥ 1mm -->OK
E4 - E6	≥ 0,8mm -->OK

Fig. 45

6.2) close the circuit-breaker and check the gap A
- If the gap A is not correct, contact ABB Sace (*)
- If the gap A is correct, open the circuit breaker and refit the arc chambers.

(*) Subject to the customer's approval, ABB can replace "A" type parts.

8.4.8. Protection releases

- Supply the protection release with a PR030/B battery unit.
- Check operation of the protection release: release test with "Trip Test" (PR121, PR122, PR123) and "Autotest" (PR122, PR123).
- Use release PR122 or PR123 to check for the absence of alarms on the display and via front LEDs.
- Use release PR121to check that there are no alarm signals via front LEDs.
- Check correct wiring of the cables to the modules of the release and to the release (if applicable).
- On PR122 and PR123 check the percentage of wear to the contacts of the switch.
- At the end, remove the battery unit PR030/B from the relay.

8.4.9. Test with SD Testbus2 (optional)

- Connect unit BT030 or BT030-USB to the relay to be tested.
- Run the programme SD.TestBus2 on a PC with a Bluetooth or USB connection, depending on the version of BT030 used.
- Once the relays and the PC have been connected, check that there are no alarm signals from the relay. If there are alarm signals, consult the paragraphs 'Error Messages' and/or 'Troubleshooting' in this manual
- In normal operating conditions, the trip test and the autotest can be run (depending on the type of relay),
- For future checks, we advise inserting the current date in the User Data and/or Tag Name area.
- Remove the BT030 or BT030-USB from the relay.

8.4.10. Maintenance operations; final checks:

- Refit each part and if necessary reconnect the auxiliary supply.
- Refit the cap as indicated in figure 46.

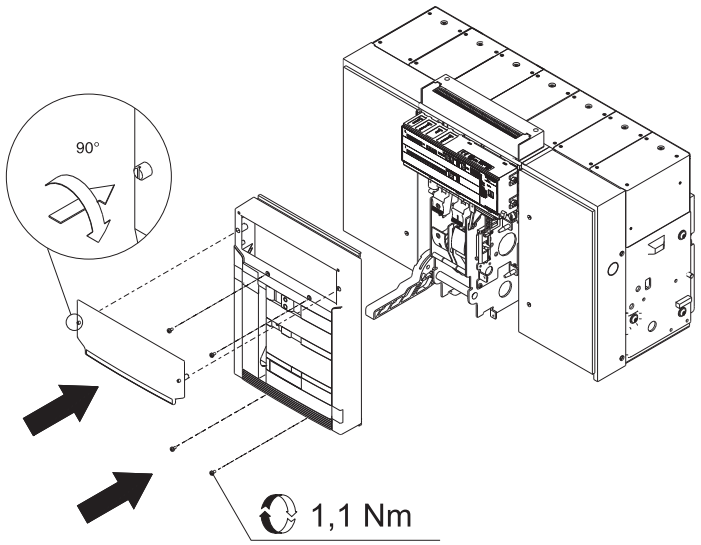


Fig. 46

- Return the movable part to the position TEST-ISOLATED.

- Use the different auxiliaries in turn to run the following 10 operations:
    - opening (both local and remote as applicable)
    - closing (both local and remote as applicable)
    - release by trip test from the relay
- Check the operations according to this sequence:
    - Open - Springs unloaded
    - Open - Springs loaded
    - Closed - Springs unloaded
    - Closed - Springs loaded

    - Check operation of the accessories, if present
    - Check operation of reduction gear (if present)
    - Check operation of minimum voltage release (if present)
    - Check operation of opening release (if present)
    - Check operation of closing release (if present)
    - Check operation of auxiliary contacts of switch (if present)
    - Check operation of lock of switch in open position (with key or padlocks) (if present)

8.4.11. Interlock

Check that the interlock devices have been correctly installed and operate correctly between adjacent and superimposed switches (if present). The operating test cannot be run in the Test or Extracted positions.

8.4.12. Extractable

In the extractable versions, check the operational efficiency of the insertion and extraction of the switch from the fixed part, performing the movement by means of the operating lever supplied and checking that the shutters for segregating the parts carrying live voltage are closed after extraction. Check correct operation of the inserted and extracted switch lock devices (if present).

9. Measures to be taken for any operating anomalies

The switch does not open when the opening button is pressed	The switch does not open when the YO operating release is tripped	The switch does not open when the YU minimum voltage release is tripped	The switch does not open when the protection relay release test is run	The switch does not shut when the close button is pressed	The switch does not shut when the YC closing coil is tripped	The closing springs cannot be loaded by the manual loading lever	The closing springs cannot be loaded by the spring loading motor	The crank does not fit in the moving part	The moving part does not rack into the fixed part	The switch cannot be locked in the open position	**Possible causes**	**Checks and remedies**
			•								The opening solenoid of the relay is not inserted correctly	Check that opening solenoid is connected correctly
			•	•	•						Warning that tripped relay has not been reset	Press the mechanical pushbutton to reset signal relay tripped
	•				•						Auxiliary circuit power supply voltage too low	Measure the voltage: it must not be less than 85% of the rated nominal coil voltage
	•				•						Different power supply voltage from the one indicated on the rating plate of the releases	Check the rating plate voltage of the releases
					•						Operating circuit faulty	Check connections, fuses, interlocks, protection circuit-breakers and consent contacts
	•				•		•				Screws for clamping loose wires and auxiliary circuits	Check tightness of the screws connecting the wires
	•				•		•				Incorrect electrical connections in the power supply circuit	Check the connections with the corresponding circuit diagram
	•				•						Damaged coil	Replace the coil
		•			•						Operating mechanism blocked	Operate by hand. If the fault persists please contact ABB SACE
				•	•						Key locked in open position	Unlock by inserting the key
				•	•						Circuit-breaker in intermediate position between connected and test	Complete the insertion operation
				•	•						Undervoltage release not energized	Check the corresponding power supply circuit and the power supply voltage
				•	•						Shunt opening release permanently energized	Check the power supply circuit
								•			Racking-in or out operation not carried out correctly	See paragraph 7.3
•		•				•					Locked control	Contact ABB SACE
				•	•						Extraction crank inserted	Extract crank
							•				Switch in extracted position	Turn switch to test or inserted position
							•				Protection fuse tripped, spring-loading motor	Replace fuse
							•				Reduction gear fault due to automatic loading of springs	Replace reduction gear
								•			Movable part incompatible with the fixed part	Check that the movable part is compatible with the fixed part
								•		•	Switch closed	Press the opening button and activate the lock
										•	Faulty open lock	Contact ABB SACE

Anomalies

WARNING: Is lit and circuit-breaker's misoperation or nonoperation in your application could cause bodily injury, property damage or is otherwise critical, remove the circuit-breaker immediately until it can be inspected or repaired.

10. Accessories

10.1. Electrical accessories

Shunt opening/closing (YO/YC) and second shunt opening release (Y02)
This allows remote opening or closing control of the apparatus. Given the characteristics of the circuit-breaker operating mechanism, opening (with the circuit-breaker closed) is always possible, whereas closing is only possible when the closing springs are loaded. Most of the releases can operate with either direct or alternating current. This release carries out an instantaneous service (*), but can be supplied permanently (**).
In uses where the shunt closing release is supplied permanently, to carry out the circuit-breaker reclosing operation after opening, it is necessary to momentarily de-energize the shunt closing release (the circuit-breaker operating mechanism reclosing is, in fact, fitted with an antipumping device).
In some versions it is necessary to have a very high degree of safety for the remote opening control of the circuit-breaker, and, in particular, the duplication of the control circuit of the shunt opening release is required. In order to achieve this, you can fit the SACE Emax circuit-breakers with a second shunt opening release. The second shunt opening release is located in the same seat as the undervoltage release and its technical characteristics are the same as the standard shunt opening release
(*) In the case of instantaneous service, the minimum duration of the current impulse must be 100 ms.
(**) In the case of permanent power supply to the shunt opening release, you must wait for at least 30 ms before giving the opening control to the shunt closing release.

Reference figures in the electrical circuit diagrams: YO (4) - YC (2) - YO2 (8)

Power supply (Un)	24 V DC
	30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-120 V AC/DC
	120-127 V AC/DC
	220-240 V AC/DC
	240-250 V AC/DC
	380-400 V AC
	440 V AC

Operating limits (CEI EN 60947-2 Standards)	(YO-YO2) : 70…110% Un
	(YC) : 85…110% Un
Inrush power consumption (Ps)	DC = 200 W
Inrush power time ~100 ms	AC = 200 VA
Continuous power (Pc)	DC = 5 W
	AC = 5 VA
Opening time (YO - YO2)	(max) 60 ms
Closing time (YC)	60 ms ± 10 ms
Insulation voltage	2500V 50 Hz (for 1 min.)

Undervoltage release (YU)
The undervoltage release opens the circuit-breaker in the case of a considerable drop or lack of its power supply voltage. It can be used for remote tripping (by means of normally closed type pushbuttons), as a lock on closing or to control the voltage in the primary and secondary circuits. The release power supply is therefore branched on the supply side of the circuit-breaker or from an independent source. Circuit-breaker closing is only allowed with the release powered (the closing lock is carried out mechanically). Most releases can operate with either direct or alternating current.

Power supply (Un)	24 V DC
	30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-120 V AC/DC
	120-127 V AC/DC
	220-240 V AC/DC
	240-250 V AC/DC
	380-400 V AC
	440 V AC

Circuit-breaker opening takes place with power supply voltage values of the release equivalent to 35 - 70% Un.
Circuit-breaker closing is possible with power supply voltage of the release equivalent to 85-110% Un.

it can be fitted with a signalling contact for undervoltage release energized (C. aux YU)..

Reference figures in the electrical circuit diagrams: YU (6)

Inrush power consumption (Ps):	DC = 200 W
	AC = 200 VA
Continuous power (Pc):	DC = 5 W
	AC = 5 VA
Opening time (YU):	≤ 80 ms
Insulation voltage	2500V 50 Hz (per 1 min.)

Time delay device for undervoltage release (D)
The undervoltage release can be combined with an electronic time-delay device for installing outside the circuit-breaker, which enables a delay in the tripping of the release with preset, adjustable times. The use of the delayed undervoltage release is recommended when the power supply network of the release can be subject to power cuts or short-lived voltage drops, in order to avoid trips.
When it is not supplied, circuit-breaker closing is prevented.
The time-delay device has to be combined with an undervoltage release with the same voltage as the time-delay device.

Reference figures in the electrical circuit diagrams: YU + D; (7).

The characteristics of the time-delay device are:

Power supply (D):	24-30 V AC/DC
	48 V AC/DC
	60 V AC/DC
	110-127 V AC/DC
	220-250 V AC/DC
Adjustable opening time (YU+D):	0,5-1-1,5-2-3 s

Geared motor for automatic closing spring loading (M)
This automatically loads the circuit-breaker operating mechanism closing springs. After circuit-breaker closing, the geared motor immediately sees to reloading the closing springs.
When there is no power supply or during maintenance work, the closing springs can still be loaded manually (by means of the special lever on the operating mechanism).

Power supply	24-30 V AC/DC
	48-60 V AC/DC
	100-130 V AC/DC
	220-250 V AC/DC
Operation limits:	85…110% Un (Norme CEI EN 60947-2)
Inrush power consumption (Ps):	DC = 500 W
	AC = 500 VA
Rated power (Pn):	DC = 200 W
	AC = 200 VA
Inrush time	0,2 s
Loading time:	4-5 s
Insulation voltage	2500 V 50 Hz (per 1 min.)

It is always supplied with limit contacts and microswitch for signalling closing springs loaded.

Reference figure in the electrical circuit diagrams: M (1)

Mechanical and electrical trip signalling for overcurrent releases
The following signals are available following tripping of the overcurrent release:

a) Mechanical trip signalling for overcurrent releases
This enables a visual signalling on the operating mechanism by pushing the trip pushbutton in when the circuit-breaker has been opened following tripping of an overcurrent release. The circuit-breaker can only be closed again by putting the pushbutton back into its normal position included in the standard configuration.
Reference figure in the electrical circuit diagrams: S51 (13).

b) Electrical and mechanical trip signalling for overcurrent releases
This enables a visual signalling on the operating mechanism (mechanical) and remotely (electrically by means of a changeover switch) of the circuit-breaker being opened following a trip of the overcurrent releases. To reset the circuit-breaker, it is necessary to reset the mechanical indicator pushbutton.
Reference figure in the electrical circuit diagrams: S51 (13).

c) Coil for resetting the mechanical release trip indicator
This enables a visual signalling on the operating mechanism (mechanical) and remotely (electrically by means of a changeover switch) of the circuit- breaker being opened following a trip of the overcurrent releases. With this accessory, you can reset the mechanical indicator with an electronic relay using a remote control and this enables the circuit-breaker to be reset.

Power supply:	24-30 V AC/DC
	220-240 V AC/DC
	110-130 V AC/DC

Reference figure in the electrical circuit diagrams: S51 (14)

Auxiliary contacts
Auxiliary contacts installed on the circuit-breaker are available to enable an indication of the circuit-breaker's status. A special version of the auxiliary contacts is also available (gold plated contacts) for a rated voltage under 24 V (digital signal).

Un	In max	T
125 V DC	0,3 A	10 ms
250 V DC	0,15 A	10 ms

Un	In max	cosφ
250 V AC	5 A	0,3

The versions available are:

a) Electrical signalling for circuit-breaker open/closed
It is possible to have electrical signalling of the circuit-breaker status (open/closed) 4, 10 or 15 auxiliary contacts.
The auxiliary contacts can have the following configurations:
- 4 break/make contacts for PR121 (2 normally open + 2 normally closed)
- 4 + 2 break/make contacts for PR122/ PR123 (2 normally open + 2 normally closed + 2 for the release)
- 10 break/make contacts for PR121 (5 normally open + 5 normally closed);
- 10 + 2 break/make contacts for PR122/ PR123 (5 normally open + 5 normally closed + 2 for the release)
- 15 supplementary break/make contacts which can be mounted outside the circuit-breake

The basic configuration described above can be modified by the user to indicate normally open or normally closed by repositioning the faston connector on the microswitch. When 10 contacts for PR122/ PR123 are required, zone selectivity and the PR120/K module are not available.
Reference Fig. in the electrical circuit diagrams: Q/1÷10 (21-22)

b) Electrical signalling for circuit-breaker connected/test isolated/disconnected
In addition to mechanical signalling of the position of the circuit-breaker, it is possible to have electrical signalling by means of 5 or 10 auxiliary contacts which are installed on the fixed part.
Only available for circuit-breakers in withdrawable versions for installing on the fixed part.
The auxiliary contacts can have the following configurations:
- 5 contacts; group consisting of 2 connected signalling contacts, 2 disconnected signalling contacts and 1 test position signalling contact (main contacts isolated, but sliding contacts connected)
- 10 contacts; group consisting of 4 connected signalling contacts, 4 disconnected signalling contacts and 2 test position signalling contacts (main contacts isolated, but sliding contacts connected)

Reference figure in the electrical circuit diagrams: S75I (31-32) - S75T (31-32) - S75E (31-32)

c) Contact for signalling closing springs loaded
This consists of a microswitch which allows remote signalling of the state of the circuit-breaker operating mechanism closing springs. The contact is always supplied with the spring loading geared motor.
Reference figure in the electrical circuit diagrams: S33 M/2 - (11)

d) Contact for signalling undervoltage release energized (C.aux YU)
The undervoltage releases can be fitted with a contact (by choise, normally closed or open) for signalling undervoltage energized for remote signalling of the state of the undervoltage release.
Reference figure in the electrical circuit diagrams: (12)

Transformers and operation counters

a) Current sensor for the neutral conductor outside the circuit-breaker
The sensor allows neutral protection by means of connection to the overcurrent release and is available only for three-pole circuit-breakers. It is supplied on request.
Reference figure in the electrical circuit diagrams: UI/N

b) Homopolar toroid for the power supply earthing conductor (star center of the transformer)
PR122 and PR123 microprocessor-based electronic releases may be used in combination with an external toroid located on the conductor, which connects the star center of the MV/LV transformer (homopolar transformer) to earth: in this case, the earth protection is defined as Source Ground Return.
The In of the toroid can be regulated to 100 A, 250 A, 400 A, 800 A by using different combinations of the connections.
Reference figure in the electrical circuit diagrams: UI/0.

c) Homopolar toroid for residual current protection
The toroid enables the residual current protection to be activated and can be combined with the PR122/P LSIRc, PR122/P LSIG releases (with PR120/V) and PR123/P. The accessory is for installation on the busbars and is available in different sizes: up to 3200A for three- and four-pole circuit-breakers, up to 4000A for three-pole circuit-breakers.

d) Mechanical operations counter
This is connected to the operating mechanism by means of a simple lever mechanism. It indicates the number of circuit-breaker mechanical operations. The indication is visible on the front of the circuit-breaker from the outside.

10.2. Mechanical locks

a-b) Lock in open positiono
Different mechanisms are available which enable the circuit-breaker to be locked in the open position.
These devices can be controlled by:
- a key (a): a special circular lock with different keys (for a single circuit-breaker) or with the same keys (for several circuit-breakers). In the latter case, up to four different key code numbers are available.
- padlocks (b): up to 3 padlocks (not supplied): Ø 4 mm..

c) Circuit-breaker lock in connected - test isolated - disconnected position
This device can be controlled by a special circular lock with different keys (for a single circuit-breaker) or with the same keys (for several circuit-breakers available up to four different key code numbers) and by padlocks (up to 3 padlocks, not supplied - Ø 4 mm).
Only available for circuit-breakers in withdrawable versions for installing on the moving part.

d) Accessories for lock in test isolated - disconnected position
In addition to the circuit-breaker lock in the connected - test isolated - disconnected position, this allows locking only in the disconnected or test isolated positions. Only available for circuit-breakers in withdrawable versions for installing on the moving part.

e) Accessories for shutter padlocks
They enable the shutters to be padlocked (installed on the fixed part) in the closed position.
Only available for circuit-breakers in withdrawable versions for installing on the fixed part.

f) Mechanical lock on compartment door
This prevents the compartment door from being opened when the circuit-breaker is closed (and connected in the case of withdrawable circuit-breakers) and prevents circuit-breaker closing with the compartment door open.

Transparent protection covers

a) Protection covers for opening and closing pushbuttons
These protection covers, applied over the opening and closing pushbuttons, prevent the corresponding circuit-breaker operations except by using a special tool.

b) IP54 door protection
This is provided by means of a transparent plastic escutcheon plate which fully protects the front of the circuit-breaker and ensures a degree of protection to IP54. Mounted on hinges, it is fitted with a key lock.

Interlock between circuit-breakers
This mechanism makes the mechanical interlock between two or three circuit-breakers (even of different sizes and in any fixed/withdrawable version) by means of a flexible cable. The electrical circuit diagram for the electrical changeover by means of a relay (to be provided by the customer) is supplied with the mechanical interlock. The circuit-breakers can be installed vertically or horizontally.
4 types of interlocks are available:
type A: between 2 circuit-breakers (power supply + emergency)
type B: between 3 circuit-breakers (2 power supplies + emergency)
type C: between 3 circuit-breakers (2 power supplies + bus-tie)
type D: between 3 circuit-breakers (3 power supplies / a single closed circuit-breaker)
The emergency power supply is generally supplied in order to substitute the normal power supply in two cases:
- to supply safety services for people.
- to supply essential parts of the installation for other than the safety services.

The change over from the normal supply to the emergency supply, can be done manually (with a local or remote control) or automatically. For the change over, the circuit-breakers must be supplied with the necessary accessories for the electrical remote control and for electrical and mechanical interlocks provided for the changing over.
The accessories can be for example:
- the shunt opening release
- the shunt closing release
- the motor operator
- the auxiliary contacts

For the change over, the customer can use a suitable electronic relay, whose diagram is supplied by ABB SACE. The mechanical interlocks between two or three circuit-breakers are made by means of cables that can be used for circuit-breakers installed, either side-by-side or one over the other.

Table of feasible mechanical interlocks between two or three circuit-breakers

Type of interlock	Number of circuit-breakers	Type of circuit-breaker	Possible interlocks
A	TWO	A normal power supply unit and an emergency unit.	The first circuit-breaker can be closed only if the second (emergency) breaker is open.
B	THREE	Two normal power supply units and an emergency unit.	The first and third circuit-breakers can be closed only if the second (emergency) breaker is open. The latter can be closed only if the first and third are open.
C	THREE	A unit of 2 supplies and a bus-tie. The two half-busbars can be supplied by a single transformer (bus-tie closed) or simultaneously by both (bus-tie open).	One or two circuit-breakers out of three can be closed at the same time.
D	THREE	A unit of 3 supplies / a single closed circuit-breaker. Three supplies (generators or transformers) on the same busbar for which parallel operation is not allowed.	Only one of the three circuit-breakers can be closed.

10.3. Spare parts and retrofitting

Spare parts
The spare parts available are:
- Complete single pole (*) (Type “A”)
- Arcing chamber
- Stored energy operating mechanism (*) (Type “A”)
- Closing springs kit (*) (Type “A”)
- Current sensors and release connecting cables
- Contact kits for clamp disconnection for a fixed part of the removable circuit breaker
- Creeping earth contacts (for withdrawable version)
- Frontal shield kit complete with caps and side shields
- Safety shutters fixed part shutters
- Transparent protection for PR121, PR122 and PR123 releases
- Opening solenoid for maximum current release PR121 / PR122 / PR123
- Testing front connecting cap for relay
- SACE PR030/B power supply unit
- Lubricating grease for stored energy operating mechanism
- Terminal board for fixed
- Creeping contacts, fixed part
- Creeping contacts, movable part
- Dust tab for door of cell
- Extraction crank
- Lifting plates pair
- Front escutcheon plate for Ronis-type key lock

For further details, ask for the ABB SACE spare parts catalogue.

(*) Subject to the customer’s approval, ABB can replace “A” type parts.

Retrofitting kits
The kits enable SACE Otomax and Novomax G30 circuit-breakers to be replaced, coupling the new circuit-breaker in the old switchboard.

11. Protection releases - General notes

Emax, the range of ABB air circuit-breakers, now has a new range of electronic relays.

These are called PR121, PR122 and PR123, and they substitute the previous range PR111, PR112 and PR113.
The new protection releases integrate all the functions of their predecessors, adding new and interesting technical features that are useful for satisfying every current and future system installation need.
Every operational requirement is now met thanks to the different performance levels of the new relays and of the additional modules that can be fitted inside them (PR120/V, PR120/K, PR120/D-M, PR120/D-BT).

A table can best illustrate the technical features and the mix and matchability of the three relays.

Function/Unit	PR121	PR122	PR123
Current protections (L, S, I, G)	**S**	**S**	**S**
Additional protections (U, OT)	**-**	**S**	**S**
Voltage protections (UV, OV, RV, RP, UF, OF)	**-**	**S**(4)	**S**
Other protections (D, S2, Double protection G)	**-**	**-**	**S**
Harmonics analysis	**-**	**-**	**S**
Temperature protection	**-**	**S**	**S**
MCR Protection	**-**	**S**	**S**
Thermal memory	**S**	**S**	**S**
Local bus for separate auxiliary units	**S**	**S**	**S**
Wire communication (RS485)	**-**	**S**(3)	**S**(3)
Radio communication (wireless Bluetooth)	**S**(1)	**S**(1,2)	**S**(1,2)
Data Logger	**-**	**S**	**S**
Compatibility with SD.Testbus	**S**	**S**	**S**
Compatibility with PR010/T	**S**	**S**	**S**
Dual setting	**-**	**-**	**S**
PR120/V Measuring (internal voltages module)	**-**	**O**	**S**
PR120/K Signalling (internal signalling module)	**-**	**O**	**O**
PR120/D-M Com (internal communication module)	**-**	**O**	**O**
PR120/D-BT WL-Com (internal Bluetooth communication module)	**-**	**O**	**O**
Residual current protection	**-**	**O**	**O**
PR021/K (separate signalling unit)	**O**	**O**	**O**
HMI030 (separate graphics interface)	**O**	**O**	**O**
PR030/B (separate power supply unit)	**O**	**S**	**S**
BT030-USB (separate Bluetooth communication unit)	**O**	**O**	**O**

Key:
S : standard function/unit,
O : optional function/unit,
- : function/unit unavailable.

Notes:
1. : with separate BT030 unit (for temporary connections),
2. : with internal PR120/D-BT module,
3. : with PR120/D-M module,
4. : with PR120/V module.

The main features and improvements of the relay PR12x with respect to the earlier PR11x are (depending on the combination of relay-modules):
1. High current reading accuracy (1.5%) and numerous other functions.
2. The PR120/V module for measuring line voltages up to 690 V, is integrated in the relay, making a separate voltage transformer unnecessary.
3. Input can be combined with actions selectable by the user (with PR120/K).
4. Four power outputs fully-configurable by the customer in terms of status, delay and type (with PR120/K).
5. Wireless Bluetooth connection to PDA and/or PC (with PR120/D-BT or BT030-USB).
6. Freely available software for relay testing and maintenance.
7. High-performance data logger with 8 analogue signals and 64 digital signals, which can be synchronized with hundreds of events/situations of the user's choice.
8. Relay powered even with the circuit-breaker open, using the busbar voltages (with PR120/V).
9. New residual-current function (Rc).
10. Double protection G function, with simultaneous reading from two sensors (PR123 Restricted Earth fault).
11. Continuous control of the connection of the current sensors and trip coil (all relays).
12. Analysis up to the 40th harmonic.
13. Cause of trip is memorized even in self-powered mode (all relays).
14. PR121 with serial link for separate PR021/K and HMI030 module.
15. Extended neutral selection.
16. Double protection S (PR123).
17. Date and time in "real time" (all relays).

11.1. Safety notes

WARNING: this symbol gives information about operations, actions or circumstances that can cause injuries to the personnel, damage to the unit or economic losses.

Read this manual carefully and completely.
The use of this device should be reserved for qualified and expert personnel only.

If in doubt, about its safe usage, the unit must be put out of service to prevent any accidental use.

You must assume that safe usage is impossible if:
1. the unit shows visible signs of damage.
2. the unit does not function (for example with autotest or with the trip test unit).
3. the unit has been damaged in transit.

WARNING: Prior to servicing and/or replacing, the circuit-breaker must be open. Also remember to disconnect all power supplies connected.

11.1.1. Notes for dielectric stiffness tests

WARNING: Dielectric stiffness tests on the releases, inputs and outputs, are not permitted.

11.2. Abbreviations and notes

11.2.1. Abbrevations

Abbreviations	Meaning
YO	Opening coil
YC	Closing coil
BT030-USB	Power supply and bluetooth communication unit, ABB SACE - USB
CB	Circuit-Breaker (for example Emax)
CS	Current Sensor (current transformer)
Emax	Series of ABB SACE air circuit-breakers
HMI 030	Human Machine Interface
HW	Hardware
In	Rated current of the Rating Plug installed in the circuit-breaker
MT	Thermal memory
Pn	Circuit-breaker rated power
Pn_{fase}	Phase rated power
PR120/K	Internal signalling unit of alarms and trips of the circuit-breaker
PR120/V	Measuring module
PR021/K	Signalling unit
PR120/D-M	Communication module
PR120/D-BT	Wireless communication module
PR010/T	ABB SACE unit test
PR121/P	Protection relay for CB Emax
PR122/P	Protection relay for CB Emax
PR123/P	Protection relay for CB Emax
PR030/B	ABB SACE power supply unit
Relè	also called “protection unit” or “protection release”
RMS	Root mean square value
TC	Trip Coil (opening solenoid)
SdZ	Zone selectivity
UI/O	External toroid (SGR)
SW	Software
i-Test	"i-Test" button on the front of relay
Trip	CB opening, generated by the release
TV	Voltage transformer (see also VS)
Un	Rated voltage of the voltage transformers installed (phase voltage)
Vaux	Auxiliary power supply
VS	Voltage Sensor (see also VT)

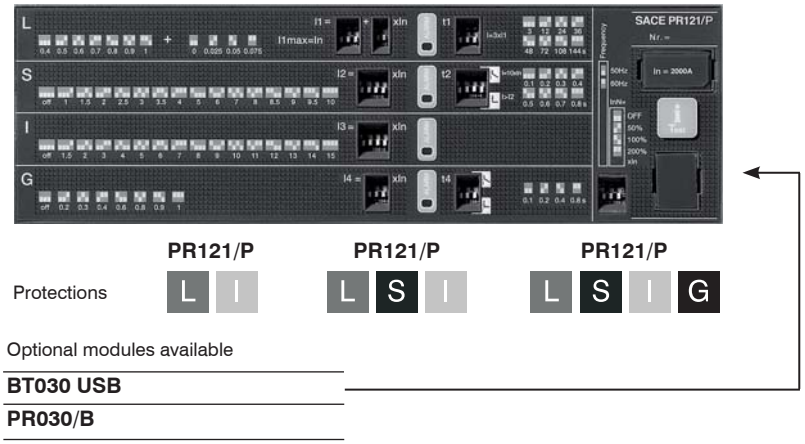
11.2.2. Notes
A. Use the “Belden 3105A”- type two-wire cable for instance (not supplied by ABB SACE).

B. Use the “Belden 3106A”- type three-wire cable for instance (not supplied by ABB SACE).

C. The unit has a “backup-protection” function; if the first command to the opening solenoid does not open immediately the circuit-breaker (TC partially fault), TRIP commands are repeatedly sent until the circuit-breaker opens (providing a Vaux is present) or the current disappears (if self-power supplied). The “backup” condition can be signalled by configuring the unit relays; using the “YO back” selection, it is possible to command the “opening coil(YO)” accessory as another opening device if TC does not work.

12. SACE PR121/P Release - Identification

The PR121/P units available, in accordance with the IEC Standards, with the various default and optional protections and modules, are illustrated in the figure below:



12.1. Standard

The PR121/P has been designed to work in accordance with the following international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers.

12.2. Specifications

12.2.1. General

The PR121/P unit is a high-performance self-supplied protection unit with Protection functions for the ABB SACE 'Emax' range of 3-pole and 4-pole low voltage air circuit-breakers. The unit's user interface also enables parameter setup and complete pre-alarm and alarm management with LED warning/alarm indicators for the protection and watchdog functions.

Depending on the version, the protections available are as follows:

Symbol	Protection against
L	overload with inverse long time delay
S	short-circuit with adjustable delay
I	nstantaneous short-circuit
G	earth fault with adjustable delay

The PR121/P can be installed on 3-pole CBs with and without an external neutral, or on 4-pole CBs.

It should be noted that the reference current for the PR121/P is the In (the rated current defined by the Rating Plug) and not the Iu (the uninterrupted rated current of the CB itself).
Example: the CB E1B800 with a 400A Rating Plug has an Iu of 800A and an In of 400A.

The unit opens the circuit-breaker in which it is installed by means of the TC, which takes effect directly on the device's mechanical leverism.
The unit is made using digital microprocessor technology and interfaces with the user by means of DIP switches. The unit's protection parameters and general operating mode can be set entirely by the user.

12.2.2. Electrical characteristics

Rated operating frequency	50/60 Hz ±10%
Pass band	2500 Hz max
Peak factor	2,1 @ 2xIn in conformity to IEC 60947 Annex F For greater peak factors,consult ABB.

12.2.2.1. Self-supply

The unit requires no outside power source for the protection and alarm signal functions. It is self-supplied by the current sensors installed on the circuit-breaker. For it to function, it simply needs the current defined below to be flowing in at least one phase. An outside power source can, however, be connected to enable other functions and particularly for its connection to the separate devices: HMI030 and PR021/K.
The characteristics of the busbar current are given in the table below:

Characteristics	Relay Enabling	
	E1...E3	E4..E6
Three-phase minimum busbar current for enabling relay (LED alive and full relay operation)	>70 A	>140 A

12.2.2.2. Auxiliary power supply

The outside auxiliary power supply is provided using a galvanically-separated power pack.

WARNING: Since the auxiliary voltage needs to be isolated from the ground, "galvanically separated converters" in accordance with the IEC standard 60950 (UL 1950) or the equivalent IEC 60364-41 and CEI 64-8 have to be used to guarantee a current in common mode or leakage current (as defined in IEC 478/1 and CEI 22/3) no greater than 3.5 mA.

The presence of the auxiliary power supply enables the relay unit to be used even with the circuit-breaker open.
The characteristics of the power pack are given in the table below:

Characteristics	Version PR121/P
Auxiliary voltage (galvanically separated)	24 V DC ±20%
Maximum ripple	5%
Inrush current @ 24V	~10 A for 5ms
Rated power @ 24V	~1 W

12.2.3. Environmental characteristics

Operating temperature	-25 °C ... +70 °C
Storage temperature	-40 °C ... +70 °C
Relative humidity	0% ... 98% with condensation
Degree of protection (with PR121/P installed in the circuit-breaker)	IP 30

12.2.4. Communication bus

Local bus on rear connector; RS485 physical interface, Modbus protocol.
Test bus on front test connector.

12.2.5. Protection functions

The PR121/P unit provides 5 independent protection functions, i.e.:
1. protection against overload with inverse time "**L**";
2. protection against short-circuit with adjustable delay "**S**";
3. protection against instantaneous short-circuit "**I**";
4. protection against earth fault with adjustable delay "**G**";
5. protection against instantaneous short-circuit at high currents "**Iinst**".

The PR121/P unit allows the neutral pole's current signal to be processed using different relationships with the value of the phases.
N.B.: Beyond 15.5xIn of current on the Ne, the protection is considered as being set to 100%.
A timing indication ("alarm" LED) is provided on the front of the unit, which is enabled during an alarm for each protection; it is disabled when the alarm condition ceases or when the protection has been tripped.
The unit also has a "backup protection" function. If the circuit-breaker does not open immediately the first time the Trip Coil is hit (partial TC failure), TRIP commands are sent repeatedly until the circuit-breaker opens.
For the inverse-time protections, the relationship between trip time and overcurrent is given by the formula: $t=k/I^2$.
For the fixed-time protections with an adjustable delay, the relationship adopted is as follows: t=k.

12.2.5.1. Calculating the RMS

All the protection functions do their respective processing on the basis of the real rms value of the currents (the protection G is disabled for current values greater than 8In [where I4>0,8In], greater than 6In [where 0.5In≤ I4<0.8In] and greater than 4In [where I4<0,5In].
If the waveform has a deformation beyond the declared limit (see peak factor), the tolerance for the calculation of the true rms value will increase.

12.2.5.2. Measuring Function

A current measuring function (ammeter) is available on all versions of the PR121/P unit.
This function can be accessed through a PR10/T test unit only via a test bus and through HMI030 via a local bus.
With auxiliary voltage, the protection records a historical of the maximum current read.

12.2.5.3. Watchdog

The PR121/P unit provides some watchdog functions to guarantee the proper management of relay malfunctions. These functions are as follows:

- ❑ RATING PLUG validity.
- ❑ Watchdog for proper current sensor connection (CS). Any anomalies are indicated by the LED coming on, as explained in par. 12.7.1.
- ❑ Watchdog for proper opening solenoid connection (TC). Any anomalies are indicated by the LED coming on, as explained in par. 12.7.1.
- ❑ Watchdog for protection against Hw Trip. If the sensors are disconnected or there is a Rating Plug error, when activated, a CB opening command is issued due to the TC being activated. This function can be activated through a PR010/T test unit.

12.2.6. Description of the protection functions

12.2.6.1. Protection "L"

The "L" is the only protection that cannot be disabled because it is for self-protection against overloading of the relay itself.
The type of curve that can be set is $t=k/I^2$.
The inverse-time protection trip time is given by the expression:

$$\text{Max}\left[\frac{9\cdot t_1}{(I_f / I_1)^2}, 1\right] \text{ where } I_f \le 12\text{In, 1 s where } I_f > 12\text{In}$$

I_f is the fault current and I_1 the protection threshold, established by the user.
NB: Time expressed in seconds.

12.2.6.1.1 Thermal memory "L"

The thermal memory function can be enabled to protect the cables. It is based on the "τL" parameter defined as trip time of the curve (t1) selected @1.25xI1. This function can be enabled through PR010/T, or SD-Testbus2.
The trip time of the release surely is 100% of the time selected after a τL time has elapsed from the last overload or last trip, or else trip time will be reduced depending on the overload and time elapsed.

PR121/P is equipped with two instruments to make up this thermal memory. The first one is only effective when the release is powered (it also records overloads that have not lasted long enough to trip the release); the second operates even when the release is not powered, reducing any trip times when it closes again straight after and is enabled as soon as the circuit-breaker is tripped. The PR121/P release determines which one to use according to the situation.

12.2.6.2. Protection "S"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/I^2$) type; in the latter case, the trip time is given by the expression:

$$\text{Max}\left[\frac{100\cdot t_2}{(I_f)^2}, t_2\right] \text{ where } I_f > I_2$$

I_f is the fault current and I_2 the protection threshold, established by the user.
NB: Time expressed in seconds.

12.2.6.2.1 Thermal memory "S"

The thermal memory function can be enabled for cable protection when the curve with inverse time is selected. This is based on the "tS" parameter defined as the trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory "L" (see par. 12.2.6.1.1).

12.2.6.3. Protection "I"

This protection can be disabled; it is of the fixed time (t=k) type, and is designed for a nil intentional delay.

12.2.6.4. Protection "G"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/I^2$) type; in the latter case, the trip time is given by the expression:

$$\text{Max}\left[\frac{2}{I^2}, t_2\right] \text{ where: } I = I_f/I_4$$

I_f is the fault current and I_4 Ithe protection threshold, established by the user.
NB: Time expressed in seconds.

The PR121/P unit can provide earth fault protection, achieved inside the relay by vectorially adding together the phase and neutral currents. The fault current is defined by the following formula:

$$\vec{I_G} = \vec{I_1} + \vec{I_2} + \vec{I_3} + \vec{I_N}$$

If the circuit reveals no faults, the module of the sum of these currents is always nil; vice versa, the value of the fault current takes on a larger and larger value depending on the entity of the fault.

12.2.6.5. Protection against instantaneous short-circuit "Iinst"

This function has a single fixed-time protection curve.
When the protection is tripped, the circuit-breaker is opened by the opening solenoid (TC).

12.2.7. Summary table of protections

Protection	Disabling	Trip threshold		Trip time	Trip threshold tolerance (2)	Trip time tolerance (2)
L ($t=k/I^2$)	☐	**I1** =	0.4 - 0.425 - 0.45 - 0.475 - 0.5 - 0.525 - 0.55 - 0.575 - 0.6 - 0.625 - 0.65 - 0.675 - 0,7 - 0.725 - 0.75 - 0.775 - 0.8 - 0.825 - 0.85 - 0.875 - 0.9 - 0.925 - 0.975 - 1 x In	t1 = 3 - 12 - 24 - 36 - 48 - 72 - 108 - 144 s (1) @I_f=3I1	Release between 1.05 and 1.2 x I1	± 10% $I_f \le 6$ x In ± 20% $I_f > 6$ x In
S (t=k)	☒	**I2** =	1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 - 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	Where $I_f > I2$ t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8 s	± 7% $I_f \le 6$ x In ± 10% $I_f > 6$ x In	The best of the two data: ± 10% o ± 40 ms
S ($t=k/I^2$)	☒	**I2** =	1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 - 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8 s @ 10 In	± 7% $I_f \le 6$ x In ± 10% $I_f > 6$ x In	± 15% $I_f \le 6$ x In ± 20% $I_f > 6$ x In

Protection	Disabling	Trip threshold	Trip time	Trip threshold tolerance (2)	Trip time tolerance (2)
I (t=k)	☒	**I3** = 1,5 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 x In	≤ 30 ms	± 10%	
G (t=k)	☒	**I4** = 0,2 - 0,3 - 0,4 - 0,6 - 0,8 - 0,9 - 1 x In	Where I_f > I4 t4 = 0.1 - 0.2 - 0.4 - 0.8 s	± 7%	The best of the two data: ± 10% o ± 40 ms
G ($t=k/I^2$)	☒	**I4** = 0,2 - 0,3 - 0,4 - 0,6 - 0,8 - 0,9 - 1 x In	Minimum trip time t4 = 0.1 - 0.2 - 0.4 - 0.8 s	± 7%	± 15%
I inst	☐	Automatic, defined by SACE	Instantaneous		

(1) The minimum value of this trip is 1s regardless of the type of curve set (self-protection).

(2) These tolerances apply in the following conditions:
- Self-powered relay (no start-up) with 2 or 3 supplied phases and/or in presence of auxiliary supply.
- trip time setting ≥100ms

For all cases not covered by the above hypotheses, the following tolerances apply:

Protection	rip threshold	Trip time
L	Release between 1,05 e 1,25 x I1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 10%	± 20%
Others	± 20%	

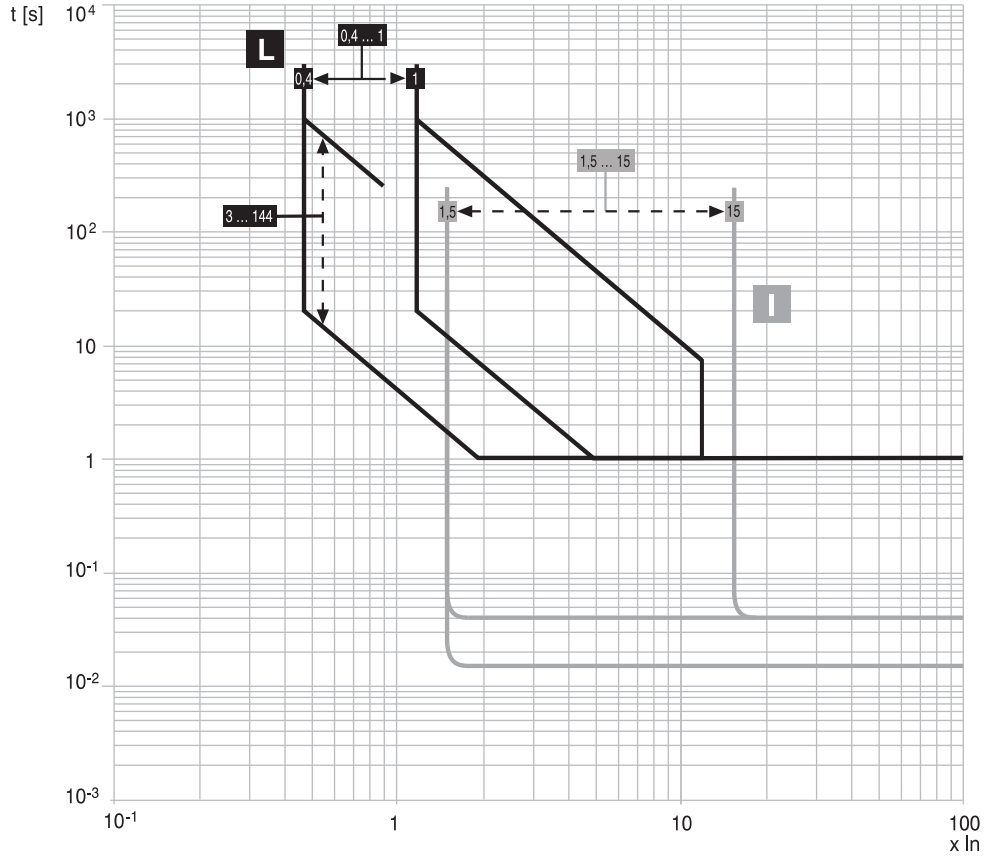
12.2.8. Table of measurements

Type of measurement	Range of values measured by the relay	Standard operation range	
		Range	Tolerance %
Phase and neutral current	0,05 ... 16 In	0,3 ... 6 In	± 1,5
Earth fault current	0,05 ... 4 In	0,3 ... 4 In	± 1,5

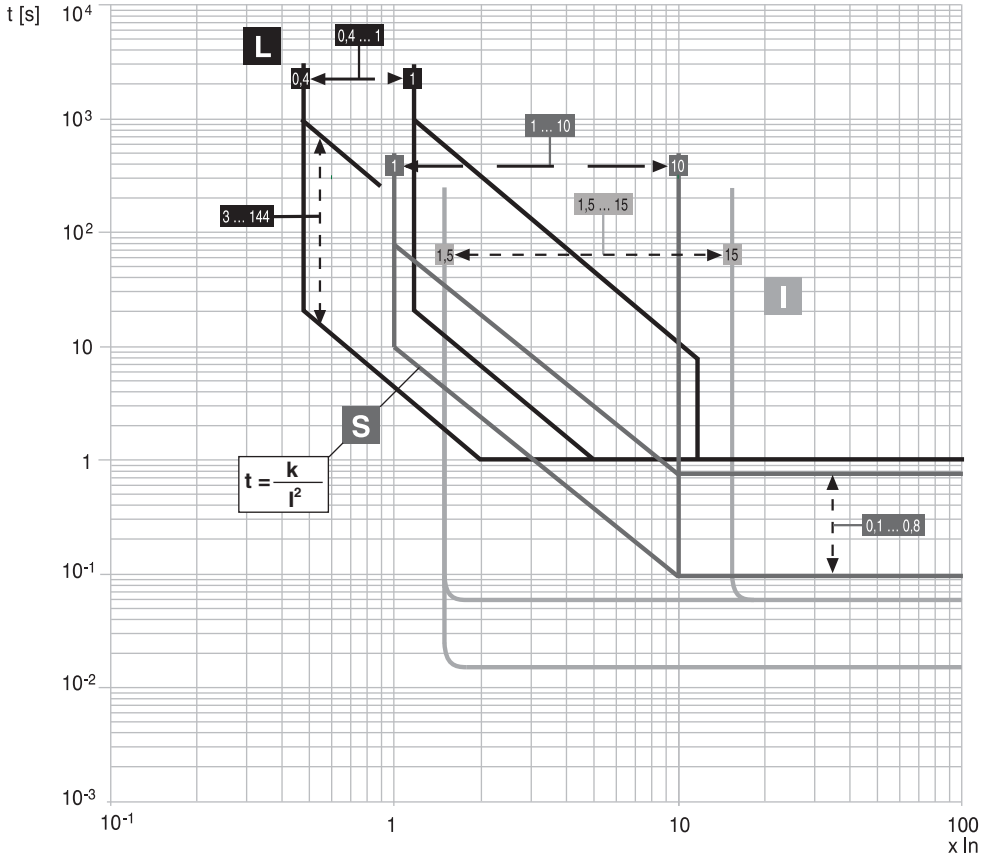
12.2.9. Trip curves

The trip curves provided are merely for guidance and only show a sub-group of the possible selections (see par. 12.2.7).

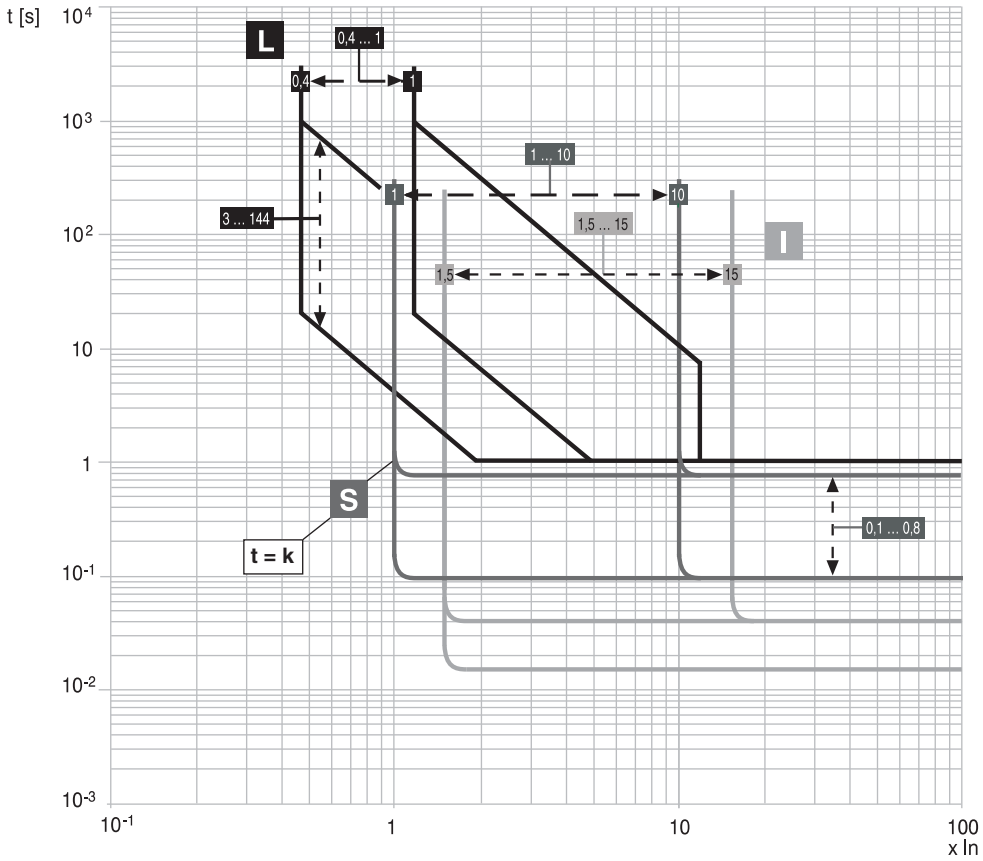
12.2.9.1. Trip curves for functions L-I



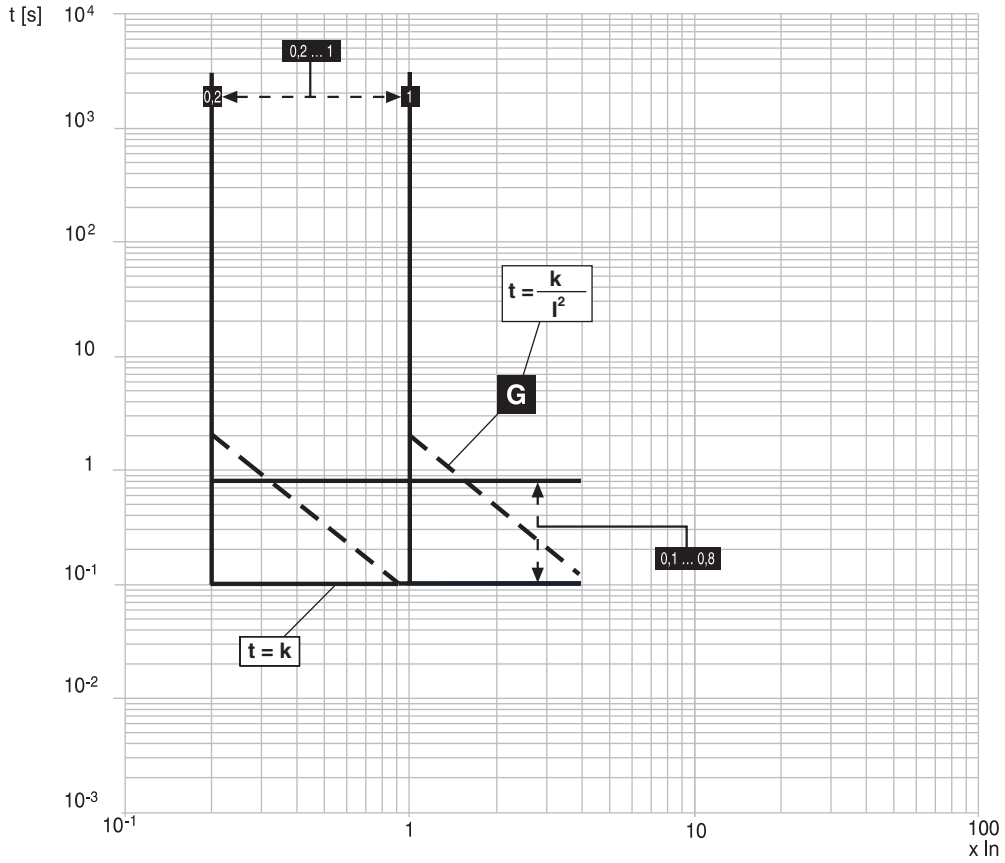
12.2.9.2. Trip curves for functions L-S(t =k/I²)-I



12.2.9.3. Trip curves for functions L-S(t=k)-I



12.2.9.4. Trip curves for function G



12.3. Other functions

12.3.1. Indication of the cause of the trip and trip test button

Using the “i Test” button, you can retrieve the information stored in the past 48 hours. You can also perform a trip test by pressing and holding the button for 7 seconds and an Autotest by pressing and holding the button for 3 seconds, again with the PR030/B battery unit connected and no current flowing through.

12.4. Putting into service

12.4.1. Connections

WARNING: For the connections provided by the user, it is recommended that you comply strictly with the recommendations contained in this document.
This will enable us to satisfy all the international reference standards and guarantee the perfect operation of the relay even under severe environmental and electromagnetic conditions. Take particular care with the earthing connections.

12.4.2. CS and TC connection check

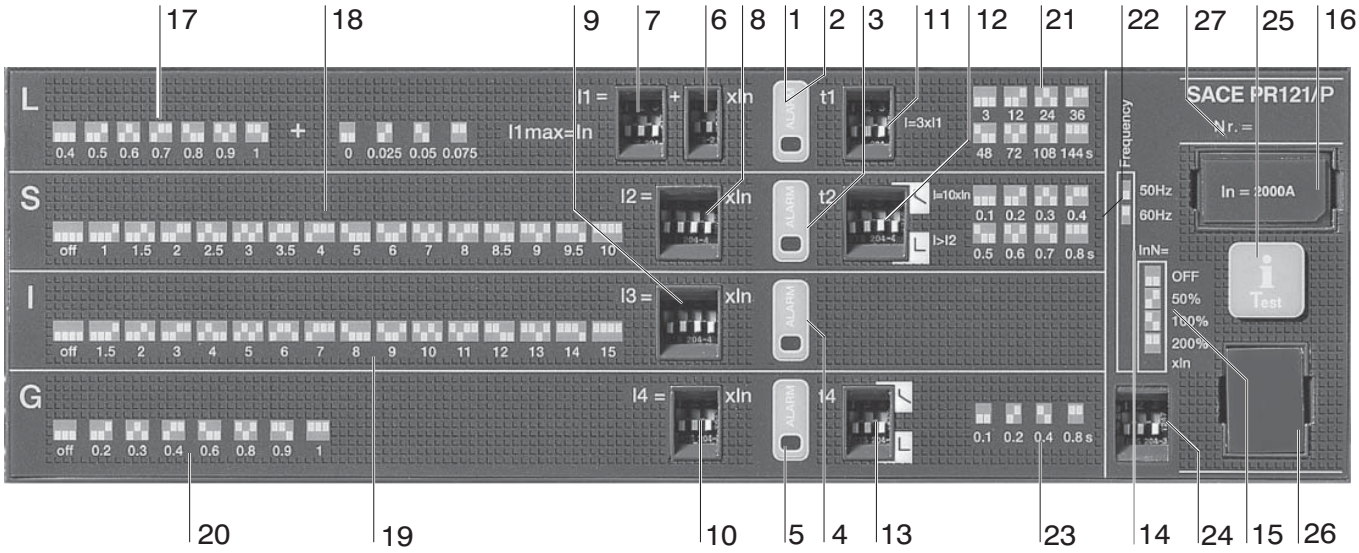
WARNING: If the PR121/P has been installed by the user, it is advisable (with the CB open and Vaux or the PR030/B) to check the proper connection of the TC and/or CS cables before putting the circuit-breaker into service; if this has not been done, make the right connections. If any of the red LEDs come on, this means an error in the connection of the CS and/or TC. See par. 12.7.1.

12.4.3. Current sensor connection for external neutral

WARNING: If you want to connect the current sensor for the external neutral conductor to a three-pole circuit-breaker, remember to set I_nN accordingly (see par. 12.5, ref. 15).
During this procedure, the circuit-breaker must be open and preferably isolated.

12.5. User interface

Captions on the front of the PR121/P unit:



Ref.	Description
1	Alarm indicator LED for protection function L
2	Pre-alarm indicator LED for protection function L
3	Alarm indicator LED for protection function S
4	Alarm indicator LED for protection function I
5	Alarm indicator LED for protection function G
6	DIP switch for fine-setting of current threshold I1
7	DIP switch for the main setting of the current threshold I1
8	DIP switch for setting current threshold I2
9	DIP switch for setting current threshold I3
10	DIP switch for setting current threshold I4
11	DIP switch for setting trip time t1
12	DIP switch for setting trip time t2 and type of curve
13	DIP switch for setting trip time t4 and type of curve
14	Position indicator for the DIP switches for the mains frequency
15	Position indicator for the DIP switches for setting the neutral protection
16	Rating plug
17	Position indicator for the DIP switches for setting the threshold I1
18	Position indicator for the DIP switches for setting the threshold I2
19	Position indicator for the DIP switches for setting the threshold I3
20	Position indicator for the DIP switches for setting the threshold I4
21	Position indicator for the DIP switches for setting the time t1
22	Position indicator for the DIP switches for setting the time t2
23	Position indicator for the DIP switches for setting the time t4
24	DIP switch for setting the mains frequency and adjusting the neutral protection
25	"i Test" test and info button
26	Test connector for connecting or testing the release using an external device (PR030/B battery unit, BT030 USB wireless communication unit and SACE PR010/T unit)
27	Serial number of the PR121/P protection release

12.5.1. Trip Test

Before you start, it is advisable to run a test ("Trip Test") on the whole TC chain by pressing and holding the button "i Test" for at least 7 s. A positive outcome is shown by the circuit-breaker opening (see Watchdog). To be able to do the test, you need to connect the PR030/B battery unit.

12.5.2. Initial settings

ABB SACE will see to applying the adhesive labels on the PR121/P for all the variables relating to the circuit-breaker (e.g. Type of circuit-breaker, Rating Plug size, etc.).
It should be noted that ABB SACE provides a sensible definition for each possible setting (see par. 12.5.4).

WARNING: Before putting the PR121/P into service, it is nonetheless absolutely essential for the user to carefully define each parameter that can be changed.

12.5.3. Changing protection functions

This paragraph enables the user to set the protection functions implemented in the PR121/P unit. Only the setting methods and which values can be selected are explained here. For all other information on the technical characteristics of the protection functions, see par. 12.2.5.

WARNING: No parameter settings can be made if the PR121/P unit is in alarm conditions.

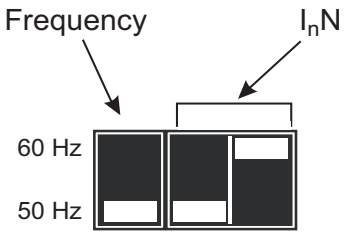
12.5.3.1. Example of settings

In the diagrams on the front plate (see par. 12.5) relating to the settings, the position of the DIP switch is indicated by the white part.

An example of how to set the DIP switch for the protection function L is given below, where I_n = 2000A:

I1 = 0,4 + 0,025 x In
I1 = 850A

t1 = 3s@2.550A (3*I_1)



Frequency = 50 Hz
I_nN = 50%

A faulty configuration of the dip-switches generates a “Settings Inconsistency” error which is signalled by means of a LED (see par. 12.7.1).
Comply with this formula: I1<I2<I3.

E.g.: if I1 = 1In and I2 = 1In, the relay signals a “Settings Inconsistency” error. The same occurs when I2 = 5In and I3 = 4In.

12.5.4. PR121/P default settings

The PR121/P is supplied by ABB SACE with the following preset parameters:

#	Protection	Threshold	Time
1	L	1 In	144 s
2	S	Off	0,1 s
3	I	4 In	--
4	G	Off	0,1 s
5	Mains frequency	50 Hz	
6	Neutral sel	*	

Note:
* = Off for 3-pole versions
* = 50% for 4-pole versions
* = 100% for full-size versions

12.6. Operating instructions / Operation in service

12.6.1. Neutral adjustment

The neutral protection is normally set to a current value 50% of the adjustment made on the phases.
In some installations, where particularly high harmonics occur, the current circulating on the neutral may be higher than that of the phases.
In the SACE PR121/P release, this protection can be set for the following values: I_nN =Off - 50% - 100% - 200% * I_n.

WARNING: With three-pole circuit-breakers, without external neutral sensor, the adjustment of the neutral must be set to OFF.

12.6.2. Neutral adjustment specifications

To adjust neutral (I_nN) comply with the following formula: I_1 x I_nN≤Iu.
With a 4-pole CB, this setting is checked by the relay which signals any failure by means of a LED (see par. 12.7.1) and independently adjusts this parameter, restoring it to within the accepted limits.
With a 3-pole CB, with external neutral, the relay performs no checks and setting is to be done by user.

E.g.: With E1B800 CB having a 400A Rating Plug, Iu = 800A and I1 = 1In, I_nN adjustment may be: 50-100-200% .
With E1B800 CB having a 800A Rating Plug, Iu = 800A and I1 = 1In I_nN adjustment may be: 50-100%.

Note 1: I_1=1I_n setting is intended as the maximum adjustment of the protection against overloads. Actual maximum allowable adjustment must take into account any temperature derating, terminals used and altitude, or In (rating plug)≤ 50% of circuit breaker size.

WARNING: Failure to comply with the setting limits for “I_1” and “I_nN” can damage the circuit-breaker, with consequent risks to the operator too.

12.6.3. Replacing an electronic release

To complete the procedure for installing PR121/P take the following steps:

1. With the circuit-breaker open and possibly disconnected, install the protection unit on the circuit-breaker.
2. Power the unit with the PR030/B ONLY.
3. If there are no errors other than the configuration error (see par. 12.7.1), press and hold the “i Test” button for a few seconds until all the red LEDs start to flash to confirm that installation is complete.
4. Remove the PR030/B.
5. Power the relay from any supply (Vaux, PR030/B, PR010/T).
6. Make sure there are no configuration errors (“Alive” LED on).
7. Circuit-breaker and release can now be put into service.

12.7. Definition of the alarms and signals for the PR121/P unit

12.7.1. Optical signals

The following table shows how the LEDs are managed in accordance with the IEC standard 60073 (and clause 4.2.3.2 in particular). 4.2.3.2).
The LED alerts you to the status of the function set on its zone; e.g. in the figure in par. 12.5 the LED referenced as 1 identifies the status of the function L. Also see the table below:

Type of information	Flashing slowly (0,5Hz)	Flashing fast (2Hz)			LED flashing with two 0.5 sec pulses every 2 sec		LED flashing with one pulse every 3 sec	LED on permanently		
	All LEDs	All LEDs	Single LED		All LEDs	LED	LED	All LEDs	Single LED	
	RED	RED	RED	ORANGE	RED	ORANGE	ORANGE	RED	RED	ORANGE
TC error or TC disconnected		☒								
CS error or disconnected	☒									
Rating Plug/Install. error					☒					
Protection timing alarm			☒							
Last trip (1)									☒	
Test button pressed and no failure detected (2)								☒		
Hardware Trip (3)									☒(4)	☒
L prealarm										☒(7)
Configuration error (5)				☒						
Settings inconsistency						☒				
Normal relay operation (6)							☒			

(1) Information on the “Last trip” is displayed when the LED relating to the protection unit that has been tripped comes on. The LED remains on for 2 sec, or permanently if an outside power supply (from the PR030/B) is being used).
(2) The information is displayed with all the LEDs on for as long as the test button is pressed and held, or for 2 sec.
(3) When enabled, Hardware trip causes opening of the CB in 1 sec., activates in case of “Cs Error” or “Rating Plug Error”, or when Ne protection is set to “ON” on the 3p CB without external neutral (configuration error).
When Vaux and/or PR030/B are installed (connected during the event), trip cause is displayed (CS Error, Rating Plug Error).
When no Vaux and/or PR030/B are installed, the general “Hw trip” indication is retained and can be viewed by pressing the “I-Test” key.
(4) Orange L led and red I led on.
(5) The values entered differ from those stored. Therefore, the relay must be installed (see 12.6.3).
(6) If other signals are not present, unit’s operating mode is indicated 3 sec after the unit has been turned on.
(7) The pre-alarm range is 0.9xI1 and (1.05...1.2)xI1.

12.7.2. Troubleshooting

The following table lists a series of typical service conditions, to help you understand and solve hypothetical faults or malfunctions.

N.B.:
1. Before consulting the following table, check for a few seconds for any optical signals provided by the LEDs.
2. FN indicates the normal operation of the PR121/P.
3. If the following suggestions fail to solve the problem, please contact the ABB SACE customer support service.

N°	Situation	Possible causes	Suggestions
1	The trip test cannot be run	1. The busbar current is è > 0 2. The TC is not connected 3. PR030/B is not connected	1. FN 2. Check TC connection (see par.12.4.2) 3. Connect the PR030/B unit
2	Trip times lower than expected	1. Threshold too low 2. Curve too low 3. Incorrect neutral selection	1. Correct threshold 2. Correct curve 3. Correct neutral adjustment
3	Trip times higher than expected	1. Threshold too high 2. Curve too high 3. Curve type "t=k/I²" 4. Incorrect neutral selection	1. Correct threshold 2. Correct curve 3. Select curve type "t=k" 4. Correct neutral adjustment
4	Rapid trip, with I3=Off	Iinst tripped	FN short-circuit with high I
5	Earth fault current beyond threshold	G function automatically inhibited but no trip occurs	FN
6	Expected trip does not happen	Function OFF	FN enable protection function
7	LEDs irregularly turned on		See par. 12.7.1
8	Unexpected trip		See par. 12.7.1
9	L LED (orange) flashing		FN

12.7.3. In the case of a fault

WARNING: If the PR121/P is suspected of being faulty, if there are signs of malfunctions or it has generated an unexpected trip, we advise you to strictly follow the recommendations below:

1. Press the “i Test” button (within 48 hours of opening the CB) and make a note of which LED is on, also recording the type of CB, the number of poles, any connected accessories, the In, and the serial number (see par. 12.5).
2. Prepare a brief description of the opening (what LEDs were displayed?, when did it happen?, how many times?, was it always under the same conditions? what type of load? what current? is the event reproducible?).
3. Send/communicate all the information collected, together with the circuit diagram for the circuit-breaker, to your nearest ABB Customer Support service.

The more the information given to the ABB Customer Support service is complete and accurate, the easier the technical analysis on the problem encountered will be, enabling us to take all action to help the user without delay.

WARNING: Letting a switch run with a fault that has not been remedied may lead to an apparatus malfunction or shutdown. Remove the apparatus immediately until it can be inspected or repaired if this situation may lead to personal injury, damage or is otherwise critical.

12.8. Accessories

12.8.1. ABB SACE PR010/T test and configuration unit

Testing with the SACE PR010/T unit enables you to monitor the proper operation of thresholds and trip times of the protection functions “L”, “S”, “I”, and “G”. The test unit is wired to the relay by a dedicated connector (see ref. 26 par. 12.5).

12.8.2. BT030 USB communication unit

Using the BT030 USB wireless communication unit, the PR121/P can be connected by radio to a normal PC, thus extending the amount of information available to the user.

12.8.3. PR021/K and HMI030 units

The PR121/P can also be connected to the optional PR021/K external signalling unit (see par. 16), for the signalling by means of no-potential power contacts of alarms and tripped protections, and to the HMI030 switchboard front unit to view various kinds of information on the display.

12.8.4. PR030/B power supply unit

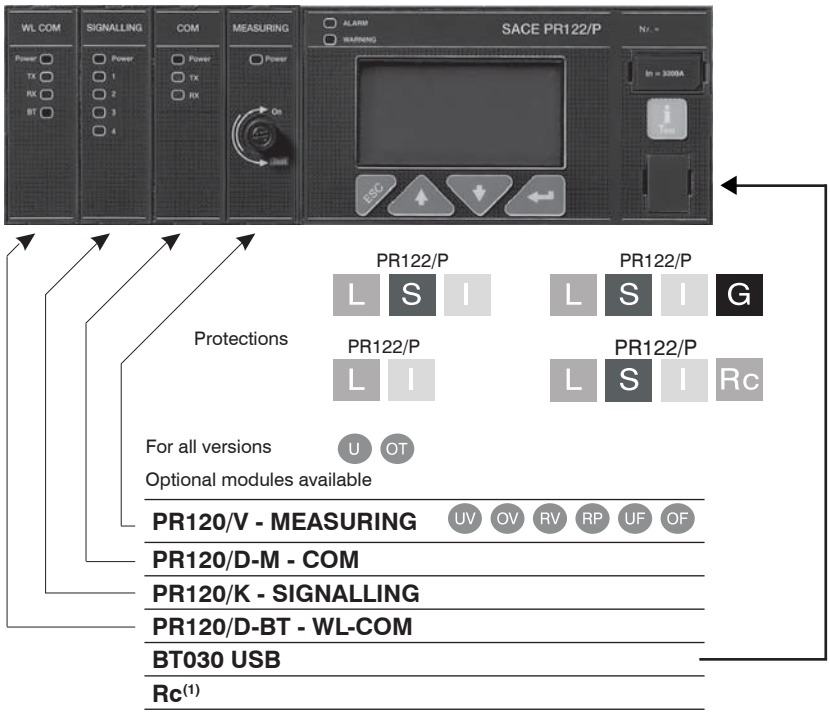
The PR030/B power supply unit is a separate unit for powering the relay, auto test, trip test and checking with CB open.

12.8.5. Flex interfaces

Flex interfaces are electronic modules with analogue and/or digital inputs and outputs that can be fitted to a DIN guide. They can be connected to the supervision system or to the electronic release by internal bus or external bus (see par.16.6).

13. SACE PR122/P Release - Identification

The PR122/P units available, in accordance with the IEC standards, together with the various protections and the various standard and optional modules, are illustrated in the following figure:



Note (1): See par. 16.5

13.1. Standard

The PR122/P has been designed to work in accordance with the international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers.

13.2. Specifications

13.2.1. General

The PR122/P is a high-performance self-supplied protection unit with **Protection, Measurement, Data storage, Communication (optional), Self-test, Load control and Zone selectivity** functions for the ABB SACE 'Emax' range of 3- and 4-pole low-voltage air circuit-breakers. The unit's user interface also enables parameter setup and complete the prealarm and alarm management for the protection and watchdog functions.

The protections available are:

Symbol	Protection against
L	overload with inverse long time delay
S	short-circuit with adjustable delay
I	instantaneous short-circuit
G	earth fault with adjustable delay
U	phase unbalance
OT	temperature out of range
MCR	closing on short-circuit

The PR122/P can be installed on 3-pole CBs with and without an external neutral, or on 4-pole CBs.
It should be noted that the reference current for the PR122/P is the In (the rated current defined by the front Rating Plug) and not the Iu (the uninterrupted rated current of the CB itself). Example: the CB E1B800 with a 400 A Rating Plug has an Iu of 800 A and an In of 400 A.

The unit opens the circuit-breaker in which it is installed by means of the TC, which takes effect directly on the device's mechanical leverism.
The protection unit is self-supplied by current sensors and primary voltages if the PR120/V module is installed.

The unit is made using digital microprocessor technology and interfaces with the user by means of a graphic display and keyboard. With the optional PR120/V module, the PR122/P also assures the following protections:

Symbol	Protection against
UV	undervoltage
OV	overvoltage
RV	residual voltage
RP	reverse active power
UF	underfrequency
OF	overfrequency
U	phase-to-phase voltage unbalance (as an alternative to phase currents)

13.2.2. Electrical characteristics

Rated operating frequency	50/60 Hz ±10%
Pass band	2500 Hz max
Peak factor	2,1 @ 2xIn in conformity to IEC 9472 Annex F. For greater peak factors,consult ABB

13.2.2.1. Self-supply

The self-supply enables the protection unit to be powered with the busbar current using current transformers.
Using this supply mode, the unit's protection functions are assured, however, not the accessory functions regarding the modules.
The characteristics are given in the table below:

General characteristics	Relay Enabling		Relay Activation	
	E1...E3	E4...E6	E1...E3	E4...E6
Minimum three-phase busbar current for enabling relay and switching on the display	>70 A	>140 A	>160 A	>320 A

13.2.2.2. Auxiliary power supply

The external auxiliary power supply is provided using a galvanically-separated power pack.

WARNING: Since the auxiliary voltage needs to be isolated from the ground, "galvanically separated converters" in accordance with the IEC standard 60950 (UL 1950) or the equivalent IEC 60364-41 and CEI 64-8 have to be used to guarantee a current in common mode or leakage current (as defined in IEC 478/1 and CEI 22/3) no greater than 3.5mA.

The presence of the auxiliary power supply enables the relay unit to be used even with the circuit-breaker open, as well as powering all the modules.
The characteristics of the power pack are given in the table below:

Characteristics	Version PR122/P
Auxiliary voltage (galvanically separated)	24 V DC ±20%
Maximum ripple	5%
Inrush current @ 24V	10 A for 5ms
Rated power @ 24V	2W
Current at pickup @ 24 V with connected modules	15 A for 5 ms
Rated power at pickup @ 24 V with connected modules	6W

13.2.2.3. Powered by the PR120/V module

For a full explanation of the features of the PR120/V, see par. 15.1..

13.2.3. Environmental characteristics

Operating temperature	-25°C ... +70°C
Storage temperature	-40°C ... +70°C
Relative humidity	0% ... 98% with condensation
Degree of protection (with PR123/P installed in the CB).	IP 30

13.2.4. Description of inputs/outputs

13.2.4.1. Binary inputs

– **K51/SZin:** Zone selectivity: input for protection S (only with Vaux)
– **K51/Gzin:** Zone selectivity: input for protection G (only with Vaux)

13.2.4.2. Binary outputs

– K51/SZout: Zone selectivity: output for protection S (only with Vaux))
– **K51/GZout:** Zone selectivity: output for protection G (only with Vaux)

13.2.5. Communication bus

Local bus on rear connector; RS485 physical interface, Modbus protocol.
External system bus, RS485 physical interface, Modbus RTU protocol, baud rate 9600-19200 bps.
Test bus on front test connector.

13.2.6. Protection functions

The PR122/P protection unit carries out 8 independent protection functions. In particular:
1. Protection against overload with inverse time “L”;
2. Protection against short-circuit with adjustable delay “S”;
3. Protection against instantaneous short-circuit “I”;
4. Protection against closing on short-circuit “MCR”;
5. Protection against earth fault with adjustable delay “G”;
6. Protection against instantaneous short-circuit at high currents “Iinst”;
7. Protection against phase unbalance “U”;
8. Protection against overtemperature “OT”.

The PR122/P unit allows current signal processing of the neutral pole with different relationships relative to the value of the phases.
N.B.: Beyond 15.5xIn of current on the Ne, the protection is considered as being set to 100%.

A timing indication (message + “alarm” LED) is provided on the unit’s display, which is activated during a protection alarm. It is disabled when the alarm condition ceases or when the protection has been tripped. When the circuit-breaker opens, the page with the “Trip” data is displayed (when “i Test” is pressed, or automatically in the presence of Vaux).

With the optional PR120/V module, the PR122/P unit also has the following protection functions:
9. Protection against undervoltage “UV”;
10. Protection against overvoltage “OV”;
11. Protection against residual voltage “RV”;
12. Protection against reverse active power “RP”;
13. Underfrequency “UF”;
14. Overfrequency “OF”.

13.2.6.1. Calculating the RMS

All the protection functions do their respective processing on the basis of the real rms value of the currents and voltages (the protection G is disabled for current values greater than 8In [where $I_4 \geq 0,8In$), greater than 6In (where $0,5In \leq I_4 < 0,8In$) and greater than 4In (where $I_4 < 0,5In$)).
If the waveform has a deformation beyond the declared limit (see peak factor) the tolerance for the calculation of the true rms value will increase. With the optional PR120/V module, the UV, OV, RV voltage protections always work on the basis of the true rms value of the voltages.

13.2.6.2. Mains frequency

The PR122/P unit constantly measures the frequency of the mains voltages it is connected to, only when a PR120/V module is installed.
If the frequency is outside the permitted range, the warning LED lights up and the warning message appears (see paragraph 13.6.3).
The signal can be combined with a relay of the PR120/K module or with those of the PR021/K unit.

13.2.6.3. Harmonic distortion

The PR122/P unit signals that a peak factor of 2.1 has been exceeded with a warning message and the “warning” LED lighting up (remember that the IEC 60947-2 standard annex “F” establishes that the protection unit must function regularly with a peak factor ≤ 2.1, up to 2xIn).
The signal can be combined with a relay of the PR120/K module or with those of the PR021/K unit.

13.2.6.4. Circuit-breaker state

If an auxiliary supply is used, or it is powered from the optional PR120/V, the PR122/P unit records the state of the circuit-breaker by means of specific wiring on the circuit-breaker. In the case where the presence of current is determined with the circuit-breaker in the “OPEN” state, a state error is signaled by a warning message being displayed (see par. 13.6) and the “warning” LED lighting up.
The signal can be combined with a relay of the PR120/K module or with those of the PR021/K unit.

13.2.7. Measurement functions

The current measuring (ammeter) function is available on all versions of the SACE PR122/P unit.
The display shows histograms with the currents of the three phases and of the neutral on the main page. In addition, the current of the phase under the greatest load is given in numerical form. Where applicable, the earth fault current is displayed on a separate page.
The ammeter functions both in self-supply mode and with an auxiliary power supply. In the latter case, or under self-powering for 3-phase currents >300A ca. or when the PR120/V module is powered, the ammeter and backlighting are always active. The tolerance for the ammeter measuring chain (current sensor plus relay) is described in paragraph 13.2.9.12.2

- Currents: three phases (L1, L2, L3), neutral (N), earth fault.
- Instantaneous current values over a given time interval (data logger).
- Maintenance: number of operations, percentage of contact wear, opening data storage (latest 20 trips and 80 events).
- The protection records the historical data of the maximum current read.

When the optional PR120/V is connected, the following additional measurement functions are provided:
- Voltage: phase-phase, phase-neutral, residual voltage.
- Instantaneous voltage values over a given time interval (data logger).
- Power: active, reactive, apparent.
- Power factor.
- Frequency and peak factor.
- Energy: active, reactive, apparent.
- Maintenance: number of operations, percentage of contact wear, opening data storage.
- The protection records the historical data of the maximum and minimum phase-to-phase voltage, total maximum and mean active power and total maximum and mean reactive power.

13.2.8. Watchdog

The PR122/P unit provides some watchdog functions able to guarantee the proper management of relay malfunctions. These functions are as follows:

- ❑ Watchdog for presence of Auxiliary power supply with “plug” icon displayed.
- ❑ RATING PLUG validity.
- ❑ Watchdog for proper connection of the current sensors (CS). If it is enabled, any anomalies are indicated by a special alarm message and the “alarm” LED coming on, and the circuit-breaker opens after 1s.
- ❑ Watchdog for proper connection of the Trip Coil (TC). If it is enabled, any anomalies are indicated by a special alarm message and the “alarm” LED coming on; if the PR120/D-M module is installed, this activates the coil opening command (YO), thus opening the CB.
- ❑ Watchdog for protection of Hw Trip. If it is enabled, in the event of the sensors being disconnected or a Rating Plug error, a CB opening command is given by the TC being enabled.

13.2.9. Description of the protection functions

13.2.9.1. Protection “L”

The “L” is the only protection that cannot be disabled because it is for self-protection against overloading of the relay itself. The types of trip curves settable are divided into two groups according to the standard they refer to.

Standard trip curve according to IEC 60947-2

Only one type of curve is settable ($t=k/I^2$) as defined by the IEC standard 60947-2.
The protection trip time - inverse time - is given by the expression:

$\frac{9 \cdot t_1}{(I_f / I_1)^2}$ where $I_f < 12In$, 1 s where $I_f > 12In$ where I_f is the fault current and I_1 the protection threshold.

NB: Time expressed in seconds.

Standard trip curve according to IEC 60255-3

There are 3 types of curves settable, defined by the IEC standard 60255-3 as A, B and C.
The protection trip time - inverse time - is given by the expression

$t = \frac{k}{(I)^{\alpha} - 1} \bullet b$ where $I = \frac{I_f}{I_1}$ where I_f is the fault current and I_1 the protection threshold specified by the user.

NB: Time expressed in seconds.

a and k are two parameters, suggested by the standard, which vary the type of slope selected
(e.g. for type B slope a = 1 and k = 13.5);
b is a parameter introduced by SACE to increase the number of curves with the same slope. This parameter is automatically calculated by setting parameter t1 (required trip time at 3xI1).

13.2.9.1.1 Thermal memory “L”

The thermal memory function can be enabled for cable protection. It is based on the “τL” parameter defined as the trip time of the curve (t1) selected at 1.25xI1.
The release trip time is certainly 100% of the one selected, after an interval τL has passed since the last overload or since the last trip. Otherwise, the trip time will be reduced, depending on the overload which has occurred and on the time that has elapsed.

The PR122/P is fitted with two instruments to make up this thermal memory. The first is only effective when the release is powered (it also records overloads that have not lasted long enough to trip the release), while the second works even when the release is not powered, reducing any trip times in the case of an immediate reclosing and is enabled as soon as the CB is tripped.
It is the PR122/P release that automatically decides which of the two to use, according to the various situations.
NB: The thermal memory function can only be set if the type of curve selected is the standard one ($t=k/I^2$) (see par. 13.2.9.1).

13.2.9.2. Protection “S”

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/I^2$); in the latter case, the trip time is given by the expression

$\text{Max}\left[\frac{100 \cdot t_2}{(I_f)^2}, t_2\right]$ where $I_f > I_2$ where I_f is the fault current and I_2 *the protection threshold*.

NB: Time expressed in seconds.

13.2.9.2.1 Thermal memory “S”

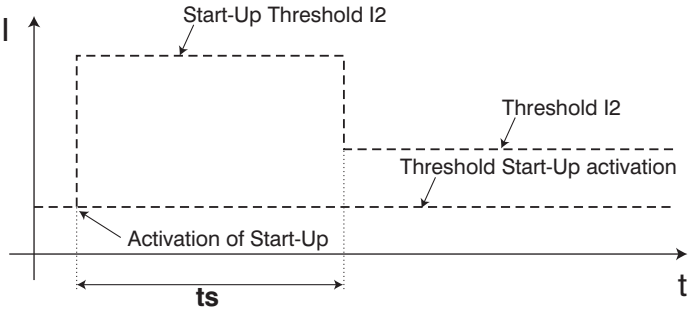
The thermal memory function can be enabled for cable protection in the case where the curve with inverse time is selected. This is based on the “tS” parameter defined as the trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory “L” (see par. 13.2.9.1.1).

13.2.9.2.2 Start-up threshold “S”

The start-up function can be selected in the case where the curve with fixed time is selected.

The function can be disabled and it is a setting characteristic of the single protection units.

The start-up function enables the protection threshold (S, I and G) to be changed during a time interval lasting “ts”, starting from “start-up”. The latter must be intended as follows:
- Passage of at least one of the phase currents above the activation threshold of the adjustable Start-Up with SD TestBus2, Ekip Connect or PR010/T (0.1…10In, by 0.1In steps); A new start-up is possible after the current has dropped below this threshold.

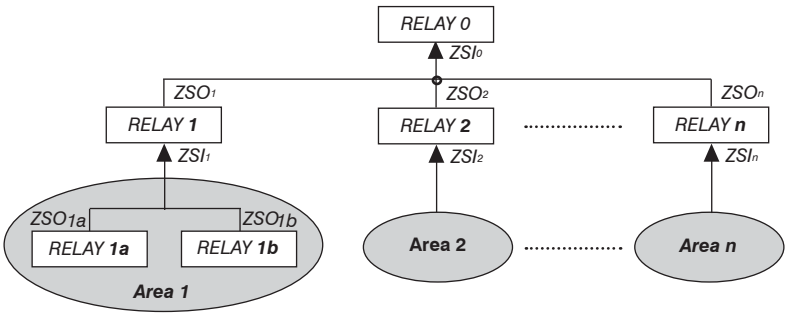


- **Start-up time**

The start-up time is common to all the protections involved.
Range: 0.1s … 30s, with steps of 0.01s.

13.2.9.2.3 Zone selectivity “S”

The zone selectivity function, guaranteed only if an auxiliary voltage is provided, enables the area of the fault to be isolated, only isolating the part of plant nearest to the fault, while keeping the rest of the plant operational.
This is done by connecting all the zone selectivity outputs of the releases belonging to the same zone to one another (ZSO=K51/SZout) and taking this signal to the zone selectivity input (ZSI=K51/SZin) of the next release on the supply side. If the wiring has been done correctly, all the zone selectivity inputs of the last circuit-breakers in the chain and all the outputs of the circuit-breakers at the head of each chain must be empty.



As a practical example, the figure above shows a fault on the load side of the “Relay 1a” isolated by the latter without the “Relay 1” or the “Relay 0” being affected; a fault immediately downstream from the “Relay 1” will be isolated by the latter without the “Relay 0” being affected, thus ensuring that the Areas 2...n remain operational.

The ZSO output can be connected to a maximum of 20 ZSI relays on the supply side in the selectivity chain.

WARNING: The maximum length of cable for zone selectivity, between two units, is 300 meters.
Use corded shielded two-wire cable (see note A to par. 11.2.2).
The shield must only be earthed on the circuit-breaker of the supply-side relay (ZSI side).

Operation is only guaranteed when there is an auxiliary voltage.
The following logical table is implemented to manage the Zone Selectivity Input (ZSI) and Zone Selectivity Output (ZSO) signals:

Zone selectivity	$I_f > I_2$	ZSI signal	ZSO signal	Trip T
Excluded	NO	0	0	No trip
Excluded	NO	1	0	No trip
Excluded	YES	0	0	t_2 programmed
Excluded	YES	1	0	t_2 programmed
Inserted	NO	0	0	No trip
Inserted	NO	1	1	No trip
Inserted	YES	0	1	$t_{selectivity}$
Inserted	YES	1	1	t_2 programmed

The time t_2 must be set at a value higher than or equal to $t_{selectivity}$ +50 ms, on the CB on the supply side, not required on the first one in the chain.

13.2.9.3. Protection “I”

The protection is enabled/disabled from the menu.
In the case where zone selectivity “S” is active, during the trip of the relay for “I”, the ZSO output signal is activated in any case

to guarantee correct operation of the relay on the supply side.

13.2.9.3.1 Start-up threshold "I"

The start-up function can be selected.
The function can be enabled from the menu on the protection "I" page.
The function behaves in exactly the same way as the protection "S" (see par. 13.2.9.9.2).

13.2.9.4. Protection "MCR" against closing on short-circuit

The MCR function is used to protect the system against closing.
If activated (the protection can be enabled/disabled), it operates only in the presence of Vaux or PR120/V, and with Protection "**I**" disabled.
The MCR function has the same functional characteristics as protection "**I**" (it uses the same control or trip algorithm), and starts operation only when the CB closes, with a time window of 0 to 40…500ms (settable by the user), after which it is deactivated.
The time window and threshold settings are set by the user.
This function can be activated through a hand-held PR010/T unit with the ABB SD-Testbus2 communication softwares or through a remote system via a system bus.
Protection "S" protects against short circuits.

13.2.9.5. Protection "G"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/I^2$); type; in the latter case, the trip time is given by the expression:

$\text{Max}\left(\frac{2}{I^2}, t_4\right)$ where $I=I_f/I_4$, I_f is the fault current and I_4 is the protection threshold.

NB: Time expressed in seconds.

WARNING: It is possible to disable the trip control of the protection ("Enable Trip: Off").
For the whole duration of the earth fault, circuit-breaker opening does not take place, but only the alarm condition is signaled ("Alarm" LED lit and alarm message).

The PR122/P unit can provide two different types of earth fault protection as **an alternative:**

Internal protection G
This is provided inside the relay by vectorially summing the phase and neutral currents. The fault current is defined by the following formula:

$$\overrightarrow{I_G} = \overrightarrow{I_1} + \overrightarrow{I_2} + \overrightarrow{I_3} + \overrightarrow{I_N}$$

In the case when the circuit does not show any fault, the module of the sum of these currents is always nil; vice versa the value of the fault current will take on an increasingly large value depending on the size of the fault. This operating mode is enabled by default.
N.B.: it can be used also with CS for an external neutral.

Protection G with external toroid "Source Ground Return"
Also called "Source Ground return", this can be carried out when there is the need to check operation of a machine (transformer, generator or motor etc.) which has star-configured windings.
The protection is assured by physically positioning an external toroid on the cable connected from the star center of the machine to the earthing connection point.
The induced current on the winding of the toroid is proportional to the fault current which, in this case, only transits in the above-mentioned toroid.
To work in this mode, "Ground protection" must be selected on the Circuit-breaker Settings menu.

WARNING: The external toroid must be connected to the PR122/P by means of a corded shielded two-wire cable (see note A in par. 11.2.2) with a length not exceeding 15m.
The shield must be earthed both on the circuit-breaker side and on the toroid side.

It is indispensable for the star center to be connected openly to earth and for it not to be used as a neutral conductor too (as in the TNC system), making a protection according to the TT system.
The minimum allowable threshold for the Gext protection is 0.1 x In (where In is the rated current of the homopolar toroidal transformer; the In settings available are 100, 250, 400, 800A), both for curve t=K both for $I^2t=K$ for release with 2.05 sw version.

13.2.9.5.1 Start-up threshold "G"

The start-up function can be selected in the case where the curve with fixed time is selected.
The function can be enabled and disabled on the protection "G" page.
The function behaves in exactly the same way as the protection "S" (see par. 13.2.9.2.2).

13.2.9.5.2 Zone selectivity "G"

The zone selectivity function can be enabled providing the fixed time curve is selected, and function is assured only if auxiliary voltage is provided.

Zone selectivity "G" can be active at the same time as zone selectivity "S".
The behavior and wiring of the function are identical to those indicated for zone selectivity "S" (see par. 13.2.9.2.3).

13.2.9.6. Protection against phase unbalance "U"

The protection with fixed time, which can be excluded, trips in the case when, for a time greater than or the same as the time t6 set, an unbalance is determined between two or more phases higher than the set threshold **I6**. Range: 2 … 90% by 1% steps.
The percentage of unbalance is therefore calculated

$\%\ Unb = \frac{I_{max} - I_{min}}{I_{max}} \cdot 100$ where I_{max} is the maximum and I_{min} is the minimum phase current.

WARNING: It is possible to disable the trip control of the protection ("Enable Trip: Off").
In that case, for the whole duration of the unbalance the CB will not be opened, but only the condition will be signaled by means of the "warning" LED lit up and a warning message.
When the value of the phase current is above 6xIn, the function "U" excludes itself because, in this case, the other protections intervene because the fault is considered as a phase fault.
The protection is not enabled for maximum phase current values lower than 0.3xIn.

13.2.9.7. Protection against overtemperature inside the relay "OT"

There is a sensor inside the PR122/P unit that monitors the temperature of the unit.
This enables the signalling of any abnormal temperature conditions, which could cause temporary or continuous malfunctions of the unit's electronic components.

This protection has two states of operation:

State of **"WARNING TEMPERATURE"** with ***–25°C < temp. < -20°C*** *or* ***70°C < temp. < 85°C*** : the display is turned off and the "WARNING" LED flashes at 0.5Hz

State of **"ALARM TEMPERATURE"** with ***temp. < –25°C*** or ***temp. > 85°C*** : the display is turned off, the "WARNING" and "ALARM" Leds flash at 2Hz and the Trip is activated (if enabled by means of the "Over Temper. Trip = On" parameter).

N.B.:
- In the event of Warning and Alarm, the display is turned off, to preserve its functionality;
- The monitored temperature is not visible on the display.

The protection is always active, both with auxiliary supply and in self-supply.

WARNING: Disabling the Trip control of the protection means that the PR122/P unit could work, with the circuit-breaker closed, in a range of temperatures where correct operation of the electronics is not guaranteed.

13.2.9.8. Load control function

Single loads can be enabled/disabled on the load side before the overload protection L intervenes and trips the circuit-breaker on the supply side. This is done by contactors or switch-disconnectors (wired outside the release), controlled by the PR122/P by means of contacts on the PR120/K module or on the PR021/K external unit.

The current thresholds are lower than those available with the protection L, so that the load control can be used to prevent tripping due to overloads. The function is active when an auxiliary power supply is present, or supply from PR120/V (see par. 15.1.4). The operating logic involves the activation of three contacts when the preset thresholds LC1, LC2 and I_w are exceeded.
Thresholds LC1 and LC2 are expressed as a percentage of I_1 (current threshold specified for protection L) while the "warning current" I_w is expressed as an absolute value. The allowable values are given in the following table:

Threshold LC1	50%...100% x I1 step 1% I1
Threshold LC2	50%...100% x I1 step 1% I1
Threshold Iw	0,3 ...10,0 x In step 0,05 In

From the PR122/P you can associate each of the PR120/K or PR121/K contacts with a configuration (NO or NC), a delay and the eventual latch.

13.2.9.9. Voltage protections "UV", "OV", "RV", "U" (PROTECTIONS AVAILABLE ONLY WITH THE ADDITIONAL PR120/V MODULE)

The PR122/P unit provides 4 voltage protections, which can be disabled, with fixed adjustable time (t = k), active both with self-supply and with auxiliary supply:
- Undervoltage "UV"
- Overvoltage "OV"
- Residual voltage "RV"
- Line voltage unbalance "U"

Apart from normal timing and "Trip" operation, the voltage protections can be in a state defined as "alarm" (with the "emergency" led on and an alarm message displayed) providing there is an auxiliary or PR120/V module power supply. In fact, in the case where the circuit-breaker is open and no current is detected, the timing leads to the "alarm" state and not to "TRIP". This is because the fault linked to the voltages can persist even with the circuit-breaker open. When the circuit-breaker is closed or the passage of a current is detected, you pass immediately from the state of "alarm" to "TRIP" without timing (see par. 13.3.2).

13.2.9.9.1 Protection "UV"

When the minimum phase voltage drops below the set threshold U_8 the protection counts down the preset time interval t_8 and then opens.

13.2.9.9.2 Protection "OV"

When the maximum phase voltage exceeds the set threshold U_9 the protection counts down the preset time interval t_9 and then opens.

13.2.9.9.3 Protection "RV"

When the residual voltage exceeds the set threshold U_{10} the protection counts down the preset time interval t_{10} and then opens.
The residual voltage U_0 is calculated by vectorially summing the phase voltages. It is therefore defined by the following formula.

$$\overrightarrow{U_0} = \overrightarrow{U_1} + \overrightarrow{U_2} + \overrightarrow{U_3}$$

This protection is available on 4-pole or 3-pole CBs with neutral voltage available (see circuit diagram 48). On 3-pole CBs, presence of neutral voltage must be set by the “neutral voltage present” parameter.

13.2.9.9.4 Protection “U”

The disable-type, fixed-time protection trips when - for a time higher than or equal to **t6** time set - an unbalance between two or more line voltages greater than **I6**, is detected. Range: 2 … 90%, by 1% Step.

Unbalance percentage is calculated as follows $Voltage\ unbalance = \frac{Max.\ deviation\ from\ mean\ d_i\ (V_{12}, V_{23}, V_{31})}{Mean\ d_i\ (V_{12}, V_{23}, V_{31})}$.

Note: alternatively to the “U” current unbalance protection

13.2.9.10. Reverse active power protection “RP” (AVAILABLE ONLY WITH THE ADDITIONAL PR120/V MODULE)

The PR122/P unit provides protection (which can be disabled) with an adjustable fixed time (t = k), against reverse active power, active both with self-supply and auxiliary supply.
When the total reverse active power (sum of the power of the 3 phases) exceeds the set reverse active power threshold P_{11} the protection counts down the preset time interval t_{11} and then opens.
The minus sign (‘-’) in front of the threshold and power indicates reverse power. The threshold is indicated as a percentage of “Pn”, where “Pn” is the rated power of the circuit-breaker (3 Vn*In).

13.2.9.11. Frequency protections “UF”, “OF” (AVAILABLE ONLY WITH THE ADDITIONAL PR120/V MODULE)

The frequency protections record the mains frequency variations above an adjustable threshold (f_{12}, t_{12}) or below (f_{13}, t_{13}), generating an alarm or the opening of the circuit-breaker.

13.2.9.12. Summary table of the protection function settings for the PR122/P

Protection	Disabling	Disabling of TRIP only	Zone selectivity	Start-up threshold	Thermal memory	Trip Threshold	Trip time	Trip threshold tolerance (2)	Trip time tolerance (2)
L ($t=k/I^2$) curve IEC 60255-3	☐	☐	☐	☐	☒	0,4xIn ≤ I_1 ≤ 1xIn step 0,01xIn	3 s ≤ t_1 ≤ 144 s(1), step 3 s @I_f=3I_1	Release between 1,05 e1,2 xI1	± 10%, I_f ≤ 6In ± 20%, I_f > 6In
S (t=k)	☒	☐	☒	☒	☐	0,6xIn ≤ I_2 ≤10xIn step 0,1xIn 0,6xIn ≤ $I_{2\ start\text{-}up}$ ≤10xIn step 0,1xIn	I_f>I2 0,05 s ≤ t_2 ≤ 0,8 s, step 0,01s 0,10 s ≤ $t_{2\ start\text{-}up}$ ≤ 30 s, step 0,01s 0,04 s ≤ $t_{2\ sel}$ ≤ 0,20 s, step 0,01s	± 7%,I_f ≤ 6 In ± 10%,I_f > 6 In	The best of the two data ± 10% o 40 ms
S ($t=k/I^2$)	☒	☐	☐	☐	☒	0,6xIn ≤ I_2 ≤10xIn step 0,1xIn	0,05 s ≤ t_2 ≤ 0,8 s, step 0,01 s @I_f=10In	± 7%,I_f ≤ 6 In ± 10%,I_f > 6 In	± 15%, I_f ≤ 6In ± 20%, I_f > 6In
I (t=k)	☒	☐	☐	☒	☐	1,5xIn ≤ I_3 ≤15xIn step 0,1xIn 1,5xIn ≤ $I_{3\ start\text{-}up}$ ≤15xIn	≤ 30 ms 0,10 s ≤ $t_{3\ start\text{-}up}$ ≤ 30 s, step 0,01 s @I_f>I3	± 10%	
MCR (t=k)	☒	☐	☐	☐	☐	6,0xIn ≤ I_5 ≤15xIn step 0,1xIn	≤ 30 ms(3) @I_f>I_5	± 10%	
G(4) (t=k)	☒	☒	☒	☒	☐	0,20xIn ≤ I_4 ≤1xIn step 0,02xIn 0,2xIn ≤ $I_{4\ start\text{-}up}$ ≤1xI_4	0,1 s ≤ t_4 ≤ 1 s, step 0,05 s 0,1 s ≤ $t_{4\ start\text{-}up}$ ≤ 30 s, step 0,01 s 0,04 s ≤ $t_{4\ sel}$ ≤ 0,2 s, step 0,01 s @I_f>I_4	± 7%	The best of the two data ± 10% o 40 ms
G(4) ($t=k/I^2$)	☒	☒	☐	☐	☐	0,20xIn ≤ I_4 ≤1xIn step 0,02xIn	0,1 s ≤ t_4 ≤ 1 s, step 0,05 s (minimum trip time) @I_f>4In	± 7%	± 15%
Gext (t=k)	☒	☒	☒	☒	☐	0,20xIn ≤ I_4 ≤1xIn step 0,02xIn 0,20xIn ≤ I_4 ≤1xIn step 0,02xIn	0,1 s ≤ t_4 ≤ 1 s, step 0,05 s 0,1 s ≤ $t_{4\ start\text{-}up}$ ≤ 1,5 s, step 0.01 s 0,04 s ≤ $t_{4\ sel}$ ≤ 0,2 s, step 0,01 s @I_f>I_4	± 7%	The best of the two data ± 10% o 40 ms
Gext ($t=k/I^2$)	☒	☒	☐	☐	☐	0,20xIn ≤ I_4 ≤1xIn step 0,02xIn	0,1 s ≤ t_4 ≤ 1 s, step 0,05 s (minimum trip time) @I_f>4In	± 7%	± 15%
Rc (6) (Idn)	☐	☐	☐	☐	☐	Idn =3,0-5,0-7,0-10-20-30A	0,06-0,10-0,20-0,30-0,40-0,50-0,80s(3	-20% ÷ 0	0,06s(5)
U	☒	☒	☐	☐	☐	2% ≤ I_6 ≤ 90% %Sbil. step 1%	0,5 s ≤ t_6 ≤ 60 s, step 0,5 s	± 10%	The best of the two data ± 10% o 40 ms
OT (temp=k)	☐	☒	☐	☐	☐	Fixed, defined by ABB SACE	Instantaneous	± 5°C	
Iinst	☐	☐	☐	☐	☐	Automatic, defined by ABB SACE	Instantaneous		

Protection	Disabling	Disabling of TRIP only	Zone selectivity	Start-up threshold	Thermal memory	Trip Threshold	Trip time	Trip threshold tolerance (2)	Trip time tolerance (2)
LC1/LC2 loads Controll	☒	☐	☐	☐	☐	50%÷100% step 1%xI_1			
Warning Iw	☒	☐	☐	☐	☐	0,3÷10I_n step 0,05xI_n		± 10%	10÷40 ms

(1) The minimum value of this trip is 1s regardless of the type of curve set (self-protection).
(2) These tolerances are based on the following assumptions:
- Self-powered relay (no start-up) with 2 or 3 supplied phases and/or in presence of auxiliary supply.
- preset trip time ≥ 100 ms.

(3) no-trip time
(4) the protection G is disabled for current values greater than 4In, where I4 < 0.5 In, greater than 6 In, where 0.5 In ≤ I4 < 0.8 In and greater than 8 In where I4≥ 0.8 In.
(5) Max trip time
(6) See paragraph 16.5

For all cases not covered by the above hypotheses, the following tolerance values apply:

Protection	Trip threshold	Trip time
L	Release between 1,05 e 1,25 x I1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 10%	± 20%
Others		± 20%

13.2.9.12.1 Summary of the additional protection functions for the PR122/P with the optional PR120/V module

Protection	Disabling	Disabling of TRIP only	Zone selectivity	Start-up threshold	hermal memory	Threshold Range	Time Range	Tolerance threshold (2)	Time Tolerance (2)
UV (t=k)	☒	☒	☐	☐	☐	0,5xUn ≤ U_8 ≤ 0,95xUn step 0,01xUn	0,1 s ≤ t_8 ≤ 5 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
OV (t=k)	☒	☒	☐	☐	☐	1,05xUn ≤ U_9 ≤ 1,2xUn step 0,01xUn	0,1 s ≤ t_9 ≤ 5 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
RV (t=k)	☒	☒	☐	☐	☐	0,1xUn ≤ U_{10} ≤ 0,4xUn step 0,05 Un	0,5 s ≤ t_{10} ≤ 30 s, step 0,5 s	± 5%	The best of the two data ± 10% o 40 ms
RP (t=k)	☒	☒	☐	☐	☐	- 0,3xPn≤ P_{11} ≤-0,1xPn step 0.02 Pn	0,5 s ≤ t_{11} ≤ 25 s, step 0,1 s	± 10%	The best of the two data ± 10% o 40 ms
UF	☒	☒	☐	☐	☐	0,9 fn ≤ f_{12} ≤ 0,99 fn step 0.01 fn	0,5 s ≤ t_{12} ≤ 3 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
OF	☒	☒	☐	☐	☐	1,01fn ≤ f_{13} ≤ 1,1fn step 0,01 fn	0,5 s ≤ t_{13} ≤ 3 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms

13.2.9.12.2 Table of measurements

Type of measurement range	Range of values measured by the relay	Standard operation	
		Range	Tollerance %
Phase and neutral currents	0,05 ... 16 In	0,3 ... 6 In	± 1,5
Internal ground fault current (internal source round return)	0,05 ... 4 In	0,3 ... 4 In	± 1,5

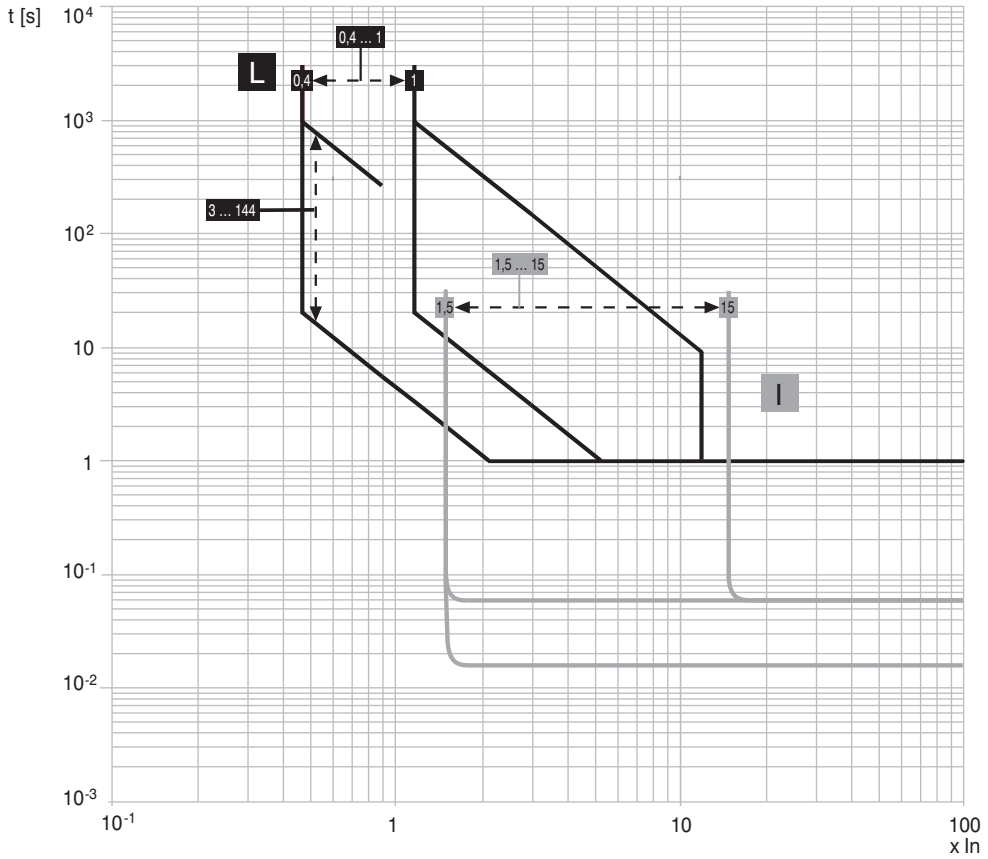
Type of measurement range	Range of values measured by the relay	Standard operation	
		Range	Tollerance %
External ground fault current (external source round return)	0,05 ... 4 In	0,3 ... 4 In	± 1,5
Phase-to-phase and phase voltages (measured at the module's input and thus independent of the precision relating to the use of any VT)	10 V_{conc} ... 1,1x690 V_{conc}	50 V_{conc} ... 1,1x690 V_{conc}	± 1
Residual voltage (for systems with neutral only)	10 V_{conc} ... 1,1x690 V_{conc}	50 V_{conc} ... 1,1x690 V_{conc}	± 1
Peak factor	0,1 ... 6 In	0,3 ... 6 In	± 1,5
Total power factor	0,1 ... 1	0,5 ... 1	± 2,5
Mains frequency	35 ... 80 Hz	45 ... 66 Hz	± 0,2
Instantaneous active power on the single phase and total system	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Instantaneous active power on the single phase and total system	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Instantaneous active power on the single phase and total system	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Active energy	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Reactive energy	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Apparent energy	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5

± 2,5
± 2,5

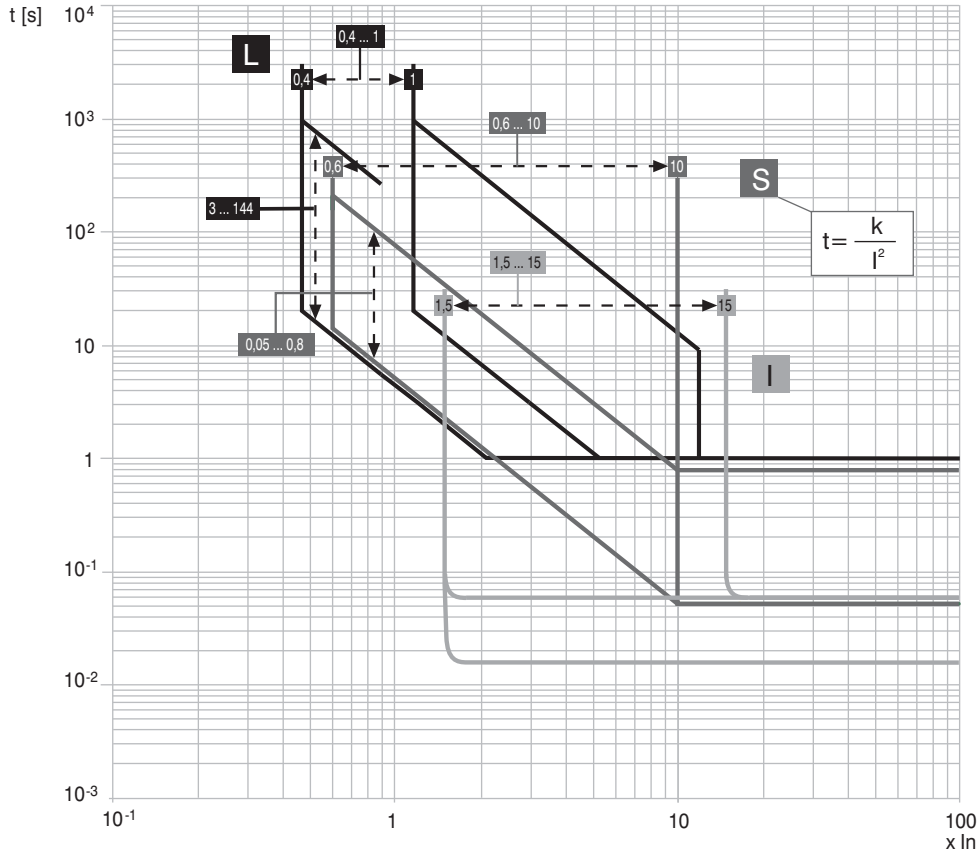
13.2.10. Trip curves

The trip curves given are for guidance and only show a sub-group of the possible selections (see par. 13.2.9.11).

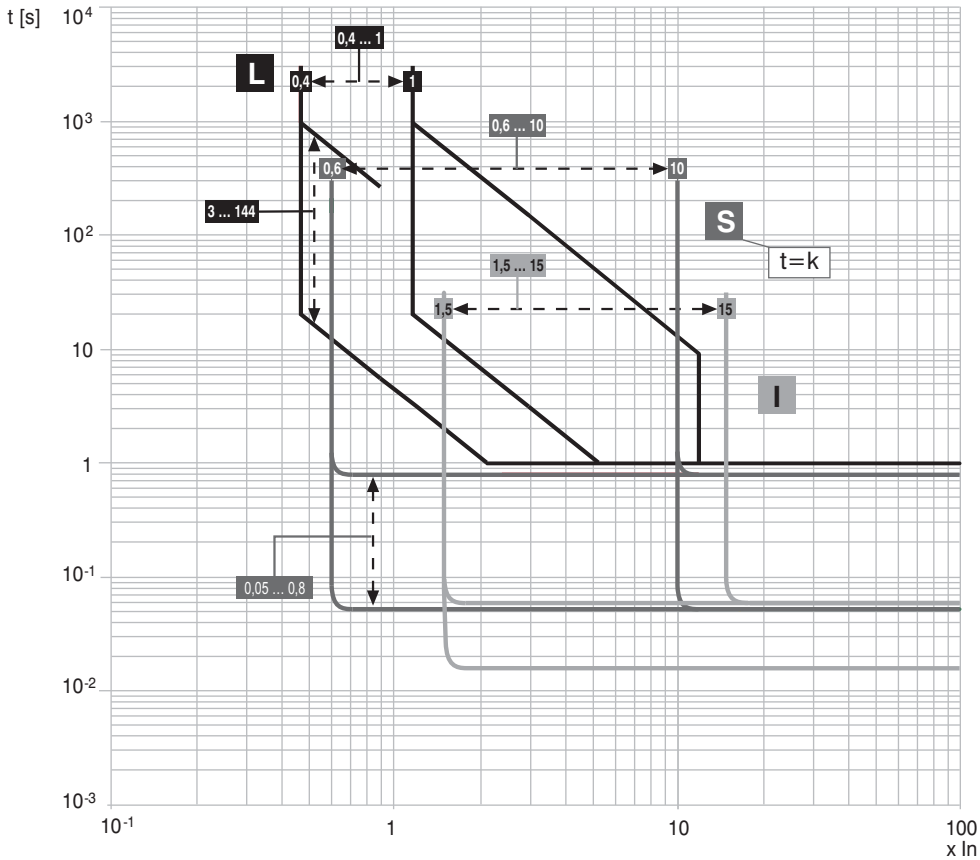
13.2.10.1. Trip curves for functions L-I



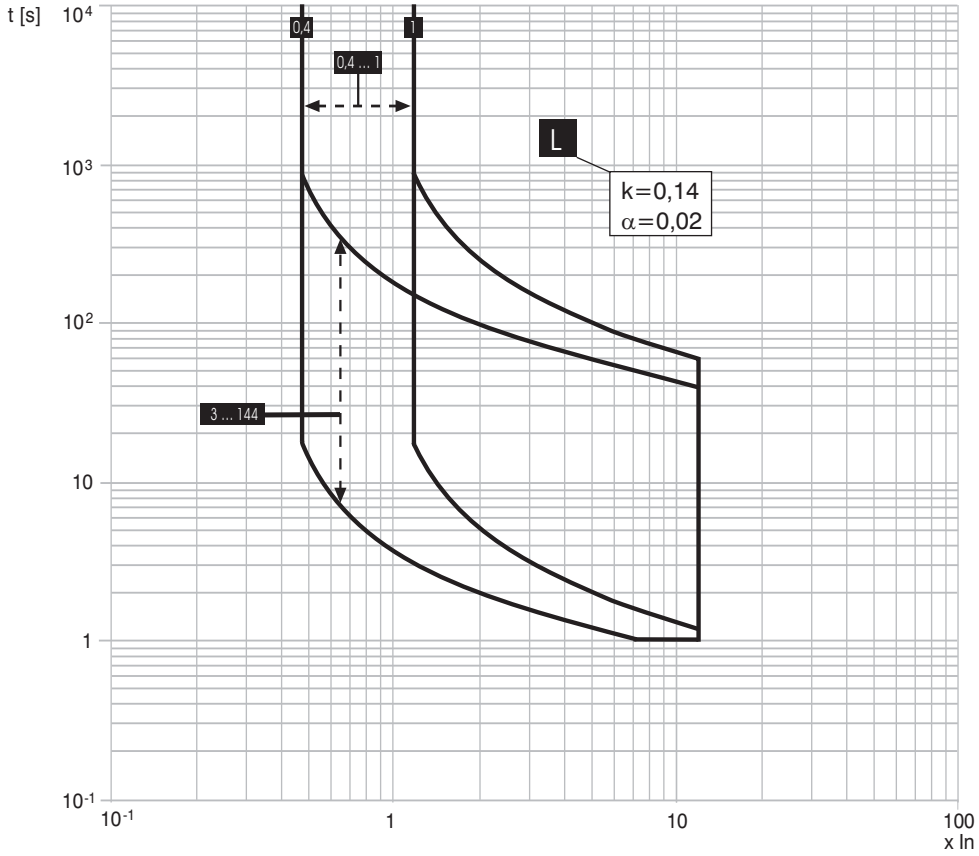
13.2.10.2. Trip curves for functions L-S(t=k/I²)-I



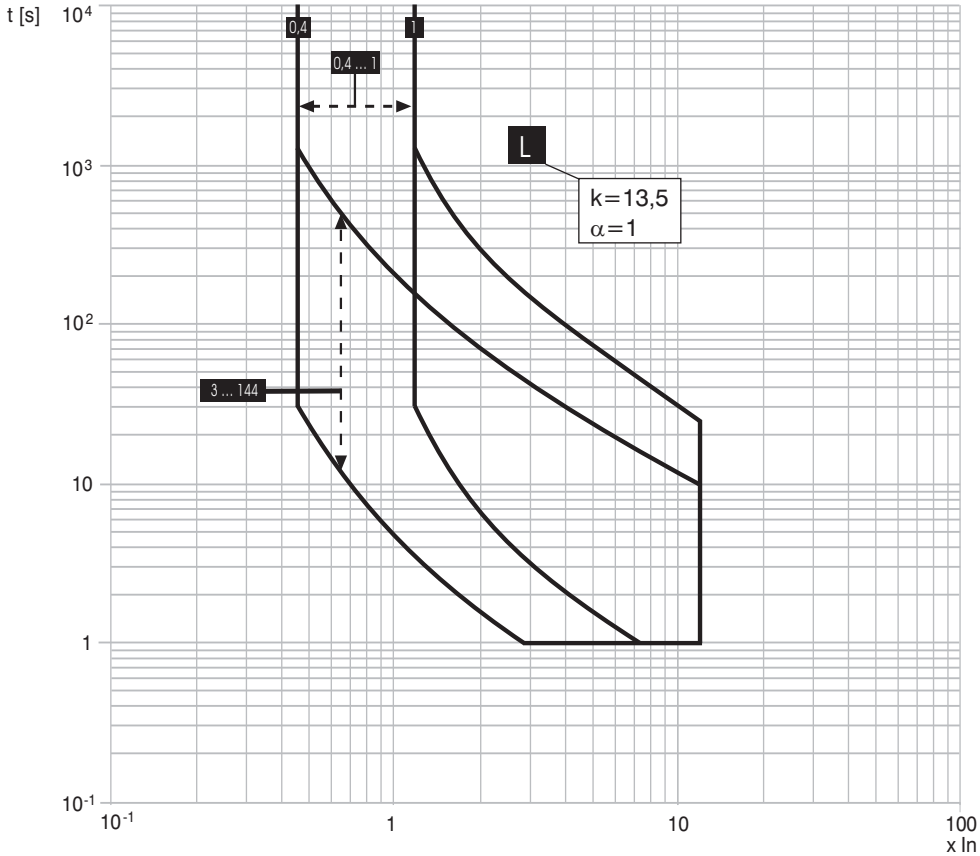
13.2.10.3. Trip curves for functions L-S(t=k)-I



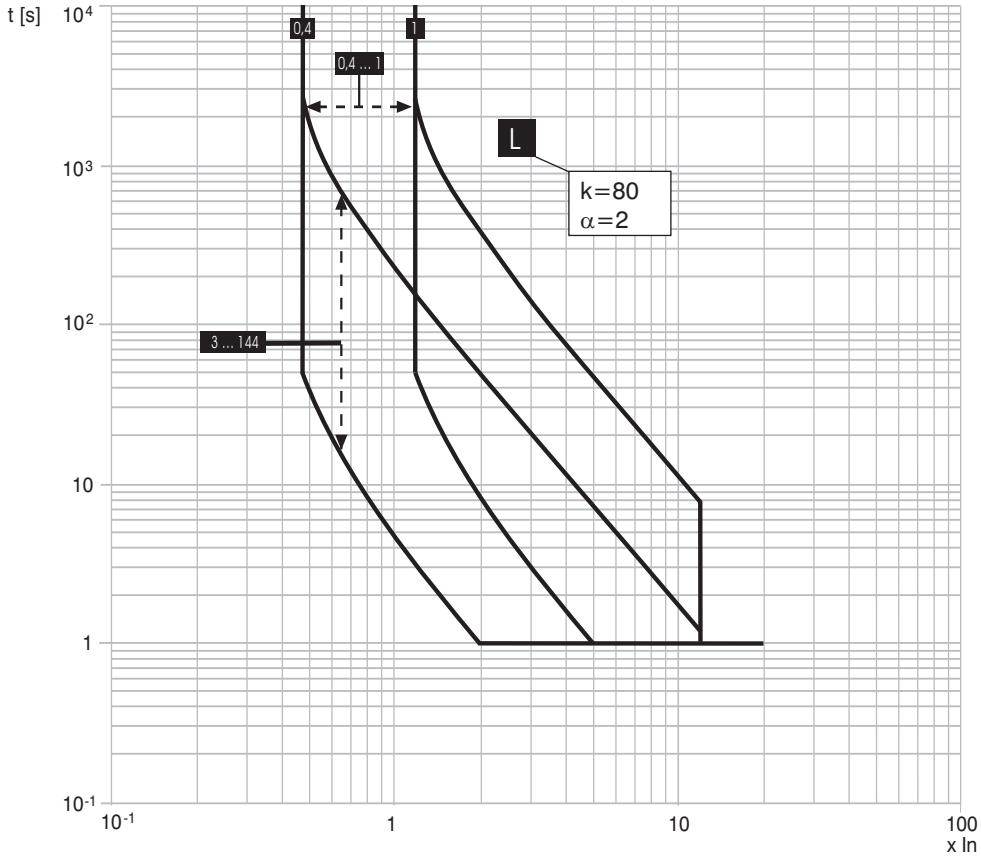
13.2.10.4. Trip curves for function L in accordance with IEC 60255-3 (type A)



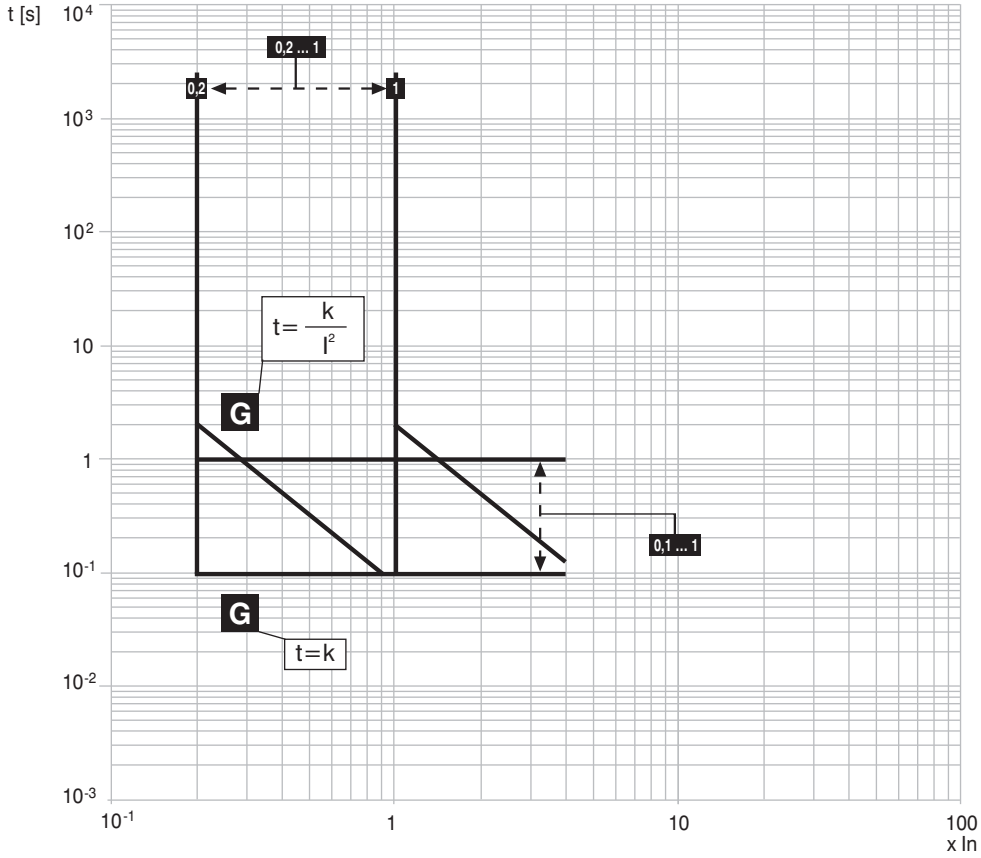
13.2.10.5. Trip curves for function L in accordance with IEC 60255-3 (type B)



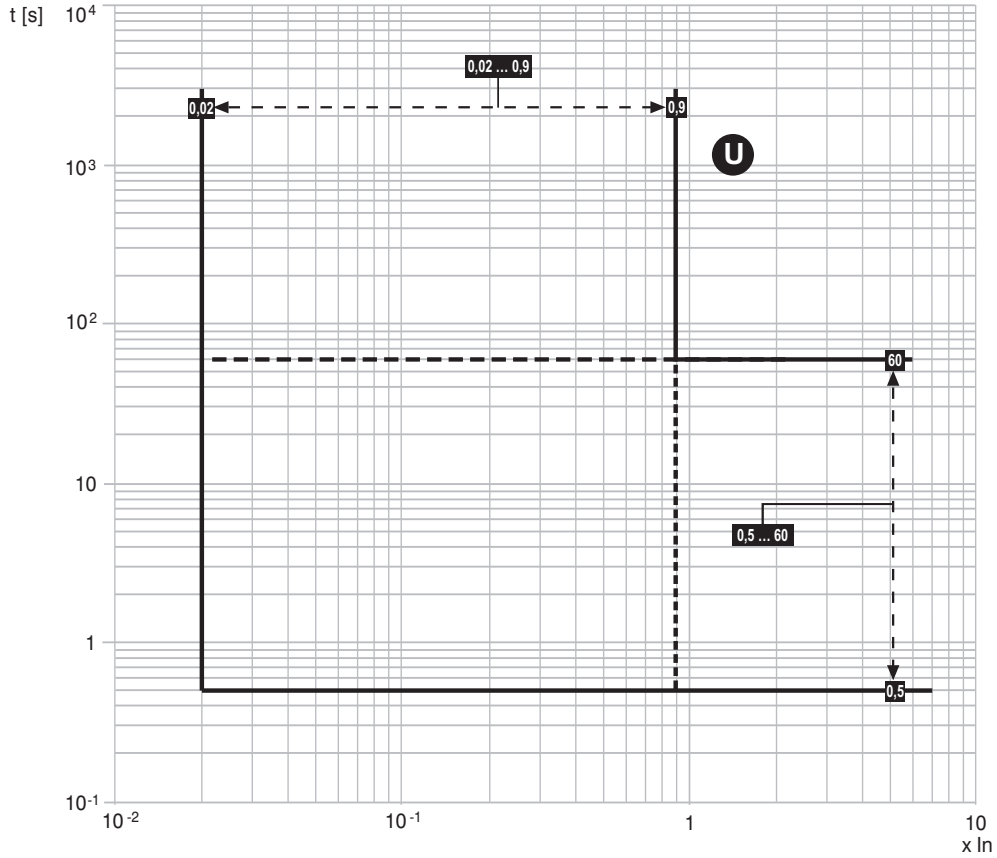
13.2.10.6. Trip curves for function L in accordance with IEC 60255-3 (type C)



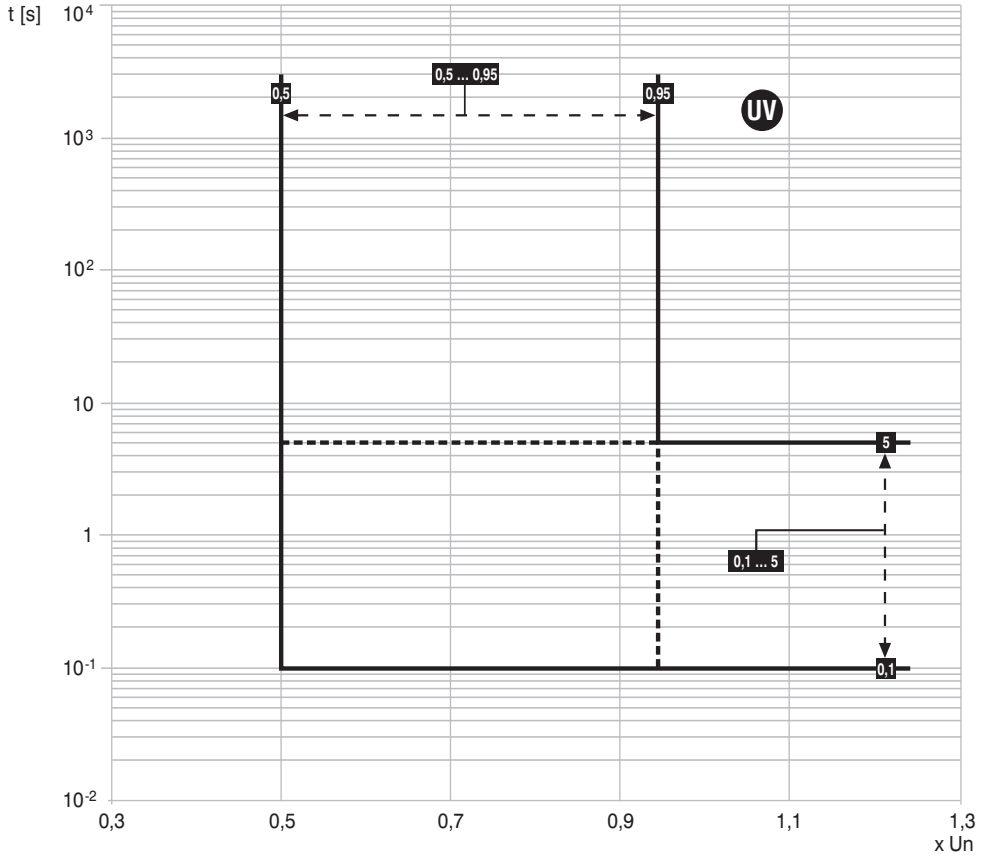
13.2.10.7. Trip curves for function G



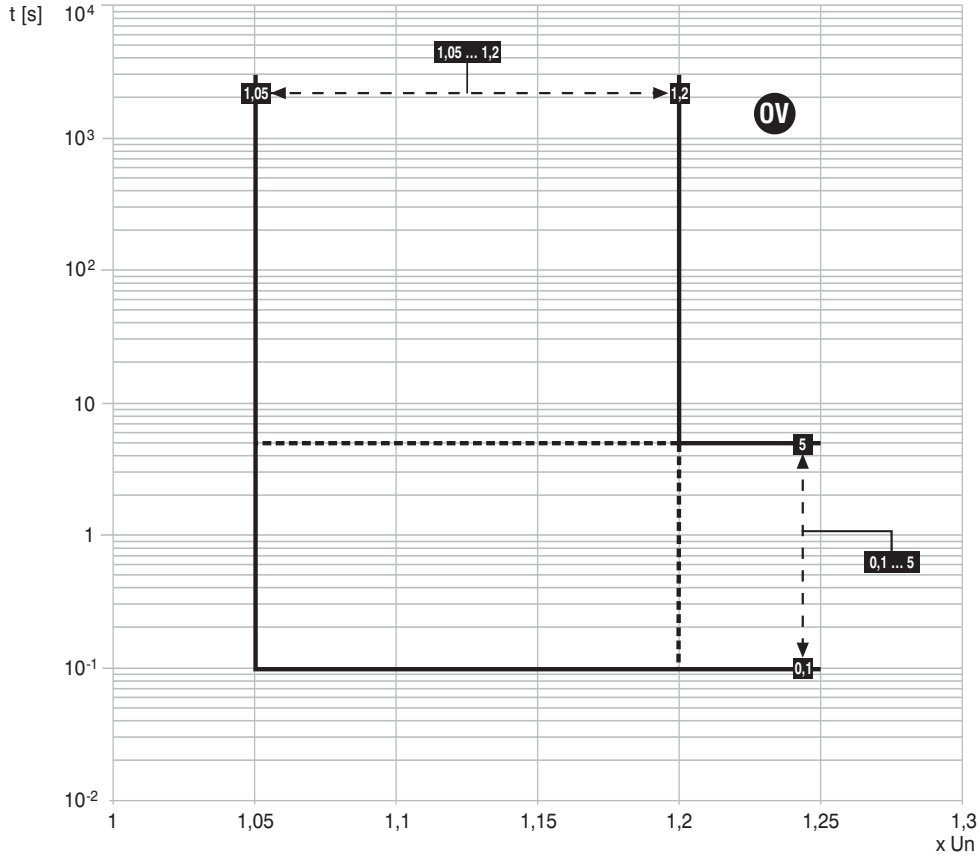
13.2.10.8. Trip curves for function U



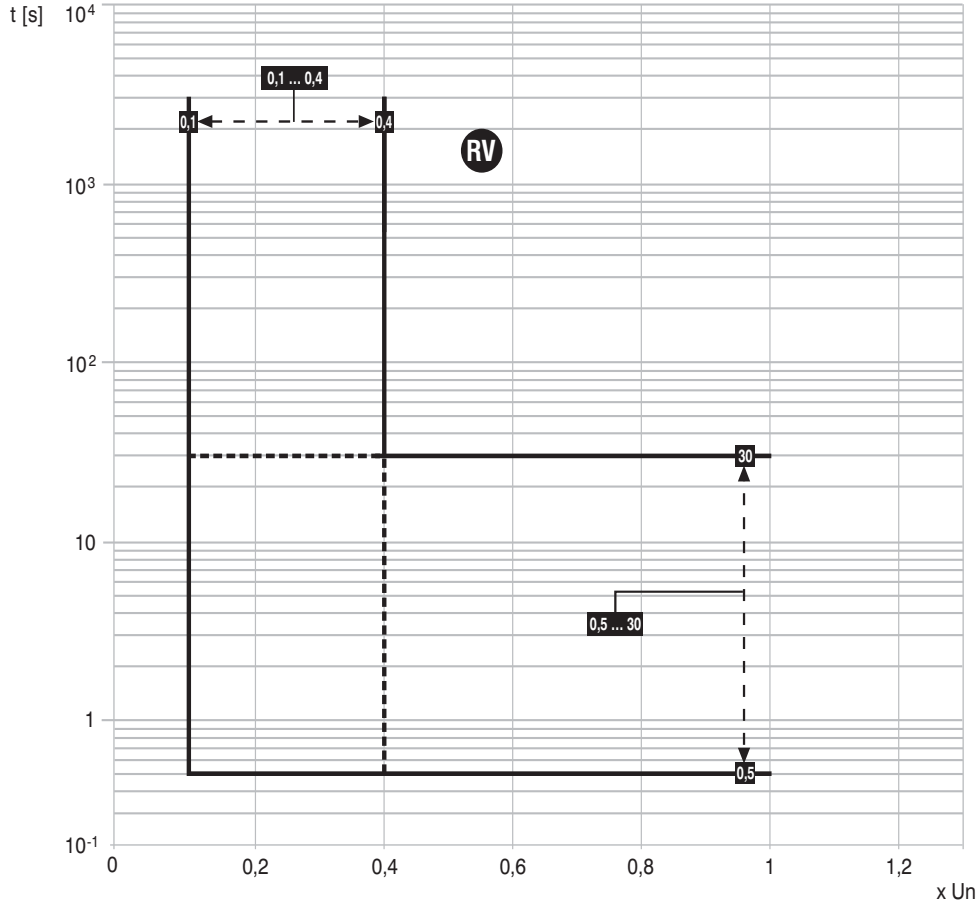
13.2.10.9. Trip curves for function UV



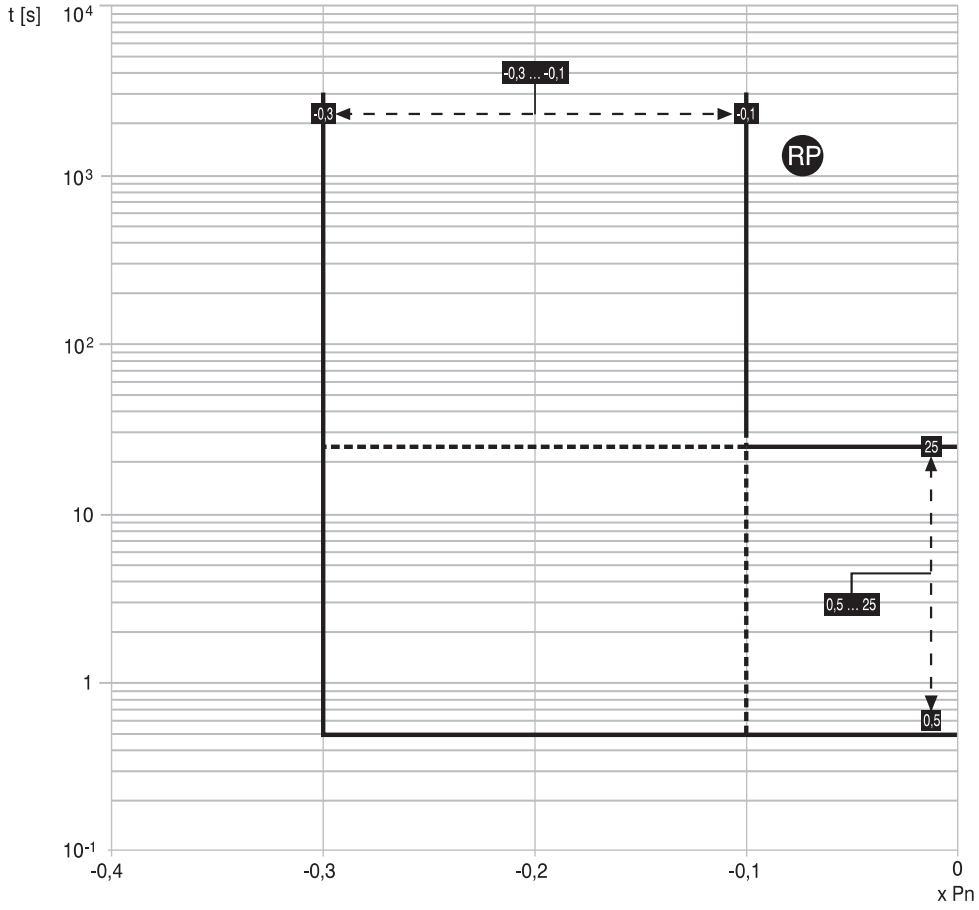
13.2.10.10. Trip curves for function OV



13.2.10.11. Trip curves for function RV



13.2.10.12. Trip curves for function RP



13.3. Putting into service

13.3.1. Connections

WARNING: For the connections provided by the user, it is recommended that you comply strictly with the recommendations contained in this document.
This will enable us to satisfy all the international reference standards and guarantee perfect operation of the relay even under severe environmental and electromagnetic conditions.
Pay particular attention to the types of cable, the connections to earth and the recommended maximum distances.

WARNING: The maximum length of the VT - PR120/V wiring must not exceed 15 meters.
Use corded shielded two-wire cable (see note A to par. 11.2.2).
The shield must be connected to earth on both sides.

WARNING: Use VTs with a shield, connected to earth (see standard VT par. 13.3.2).
The VTs should only be used for voltages > 690V; for lower voltages the presence of the PR120/V module connected to the lower or higher busbars will be sufficient. With VT available, set the Voltage Transf. data to present and suitably adjust the phase-to-phase primary and secondary voltage of the VT.

13.3.1.1. Current sensor connection for external neutral

WARNING: If you want to connect the current sensor for the external neutral conductor to a three-pole circuit-breaker, remember to set I_nN. accordingly. During this procedure, the circuit-breaker must be open and preferably isolated.

13.3.2. VT connections

WARNING: Dielectric strength tests are not allowed on the inputs and outputs of the releases or on the secondary lines of any connected VTs.

The following is a summary table of standard VT connections according to the type of plant.

VT Standard (A):

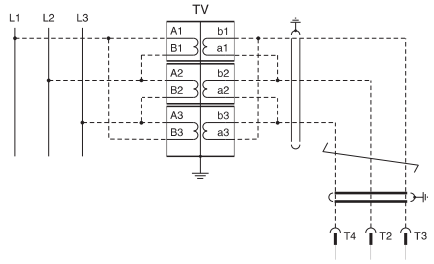
Single standard transformers, see par. 15.1.7.
The VTs must have a performance coming between the values of 10 and 20 VA inclusive, 4 kV insulation between the primary and secondary.

Installation system	"VT Standard" type transformer (Star/Star)	"VT Standard" type transformer (Delta/Delta)
	Application diagram	Application diagram
TN-C	B	A
TN-S	B	A
IT with neutral	B	A
IT	n.c	A
TT with neutral	B	A
TT without neutral	n.c	A

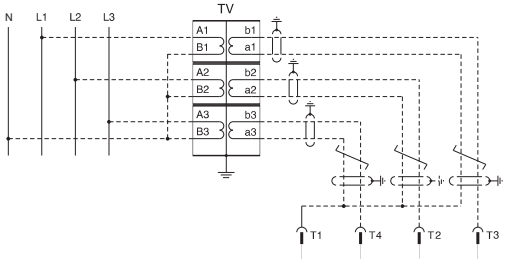
Note for diagram B:

- for TN-C systems the connection must be made to PEN;
- for TN-S systems the connection must be made to N for configurations with neutral or PE for configurations without neutral; if the PE is used, the current thereon could be around a dozen mA. If a customer considers this value too high or has a residual current protection which risks being tripped, then application diagram A must be used;
- for IT and TT systems with neutral, the connection must be made to N.

Application diagram A



Application diagram B

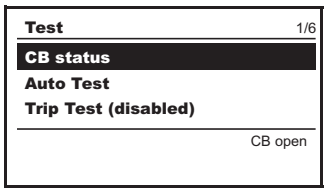


13.3.3. CS and TC connection test

WARNING: If the PR122/P was installed by the user, it is important, before closing the CB, to check the last line on the display when the relay is turned on for the first time via a PR030/B battery unit. No CS and/or TC disconnected messages must appear; if they do, do not close the circuit-breaker and make the correct connections.

13.3.4. Test

Before putting into service, a test can be conducted by means of the specific “Auto test” function which can be activated on the PR122/P. A positive result is shown on the display.
Then a test can be conducted on the whole TC chain, again using the specific function (Trip test). A positive result is shown by the circuit-breaker opening. To run a Trip Test, press the “i Test” button and the “Enter” button simultaneously.
Check the open or closed state of the circuit-breaker on the same “PR122/P Test” screen, by checking that is closed and de-energized.



13.3.5. Initial settings

If the PR122/P is supplied ready installed in the circuit-breaker, it is up to ABB SACE to set all the variables referring to the circuit-breaker or the specific application correctly (e.g. type of circuit-breaker, Rating Plug size ...). When the PR120/V module is installed, set the Rated Voltage suitably.
Vice versa, if the PR122/P is supplied separately, it will be up to the user to set all the necessary parameters correctly.
Note that ABB SACE defines each possible setting according the content of the paragraph on the default parameters (see par. 13.4.4).

WARNING: Apart from this, it is absolutely indispensable for the user to modify the password and carefully define each modifiable parameter, before putting the PR122/P into service.

13.3.6. Password management

Specify a password? [0*]**

To enter “EDIT” mode it is necessary to enter a four-figure numerical password. The values attributable to the password go from 0000 to 9999. For the default password see par.13.4.4.
Select the value of the first figure (between ‘0’ and ‘9’) by means of the ↑ and ↓ and press ↵ to confirm the figure and then move on to enter the next one.
After entering the fourth figure, check the password you have entered. If the password is correct, you go from the “READ” state to the “EDIT” state.

If the password is wrong, the message

Wrong password

appears and remains until the **ESC** (key is pressed (or until an interval of 5 seconds has elapsed).

It is also possible to interrupt the password entry procedure by pressing th **ESC** key.

The password is valid for a maximum of two minutes from the last time a key was pressed.

Disabling the Password.
By setting the value of the password to [0000] (on the “Unit configuration” menu) the password prompt is disabled. It is therefore always possible to switch from “READ” to “EDIT”.

To enter a new password, select the “New Password” item on the “Settings/System” menu.

13.3.7. Replacing an electronic release

13.3.7.1. Installation

To complete the procedure for installing a PR122/P unit, follow the steps below:

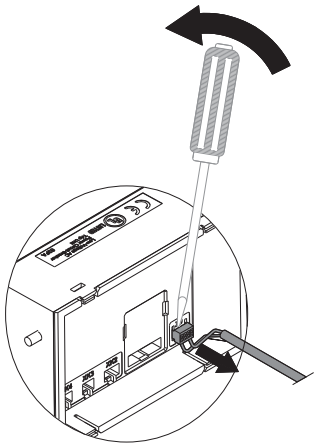
1. With the circuit-breaker open and preferably isolated, install the protection unit on the circuit-breaker
2. Power the unit ONLY from the PR030/B
3. If there are no other errors, the display will show the message Configuration (configuration error) accompanied by the yellow LED coming on permanently (warning)
4. Enter the unit’s “Settings” menu
5. Select “Circuit-breaker”
6. Select “Unit installation”
7. Input the password
8. Select “Install” and press “ENTER”
9. When the red led flashes on and off and the message Installation (installation error) is displayed, remove the PR030/B
10. Power the relay from any other source

Check for the absence of configuration errors.

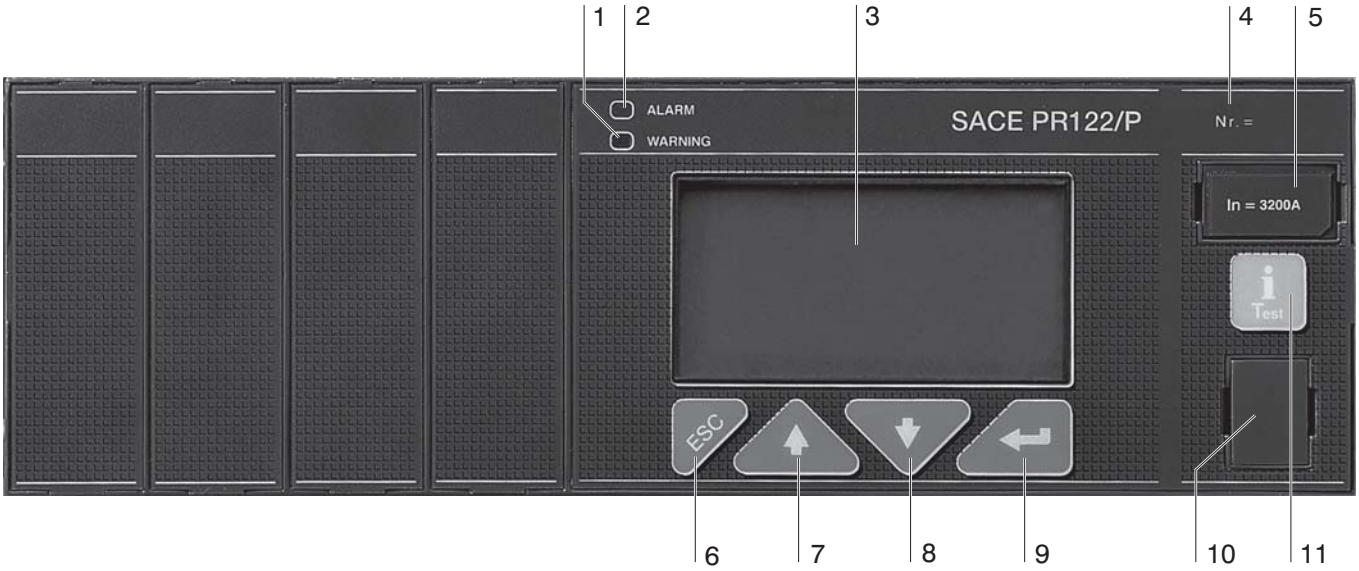
13.3.7.2. Uninstalling

To complete the procedure for uninstalling a PR122/P unit, follow the steps below:

1. With the circuit-breaker open and/or isolated power the unit from the PR030/B
2. Enter the unit’s “Settings” menu
3. Select “Circuit-breaker”
4. Select “Unit installation”
5. Input the password
6. Select “Uninstall” and press “ENTER”
7. Remove the PR030/B module
8. Remove the PR122/P unit from the circuit-breaker
9. The remove the TC connector, proceed as indicated in the figure alongside.



It is not strictly necessary to complete the uninstalling procedure, but this enables the parameters relating to the circuit-breaker, such as contact wear and others, otherwise these data would be lost. The data in question are then transmitted to the new PR122/P unit installed on the same circuit-breaker.



Ref.	Description
1	Pre-alarm indicator LED
2	Alarm indicator LED
3	Graphic display (the word ABB in the bottom left-hand corner indicates normal operation
4	Serial number of the PR122/P
5	Rating plug
6	Pushbutton for exiting the sub-menus or for canceling (ESC)
7	Button for the cursor (UP)
8	Button for the cursor (DOWN)
9	ENTER key for confirming the data or changing the page
10	TEST connector for connecting or testing the release by means of an external device (PR030/B battery unit, BT030 USB wireless communication unit and PR010/T test unit)
11	“I Test” test and info button

Description of the icons displayed

Symbol	Description
	Remote control
	Dual setting active. Setting A set
	Fixed icon: data logger activated Flashing icon: triggering
	Vaux installed
	Parameter change stage

The Graphic Display is of the LCD type with 128x64 pixels and it is backlit when there is an auxiliary voltage or a self-supply from a PR120/V module or 3-phase current >300A ca.
The display is always lit when there is a Vaux or, in self-supply mode with a minimum busbar current or powered from the PR120/V module as defined in par 13.2.2.1.
You can adjust the contrast on the display by means of the specific function available on the user interface settings menu (par. 13.5.4.1).

13.4.1. Use of pushbuttons

The modifiable fields can be filled in using the ↑ or ↓ keys and confirming with the ↵. Once you have entered the page you need, you can move from one value to another by using the ↑ or ↓. To change a value, position the cursor over the value (the modifiable field will appear in reverse, i.e. white on a black background), and use the ↵ key.

To confirm the programming of the previously configured parameters, press the **ESC** key to scroll up the menus till the programming confirmation page will be displayed; select confirmation and press **ENTER** for data programming.

The **“i Test”** key must be used to perform the Trip test to view the information page and to see the last trip within 48 hours of the CB opening in self-supply mode.

13.4.2. Read and Edit modes

The menus map (see par. 13.5.1) shows all the pages which can be obtained and how to move between them from the keyboard, in the “READ” mode (just to read the data) or in the “EDIT” mode (to set the parameters).

Starting from any page displayed, after about 120 sec of inactivity, the default page will be automatically displayed (see par. 13.5.1).

The functions allowed depending on state are:
“READ”:
- ✓ Consultation of the measurements and of the historical data
- ✓ Consultation of the unit configuration parameters
- ✓ Consultation of the protection parameters

“EDIT”:
- ✓ Everything allowed in READ mode
- ✓ Configuration of the unit
- ✓ Programming of the parameters relative to the protections
- ✓ TEST Functions of the unit

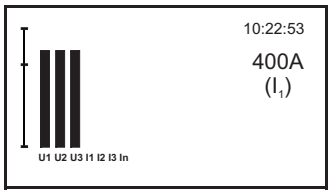
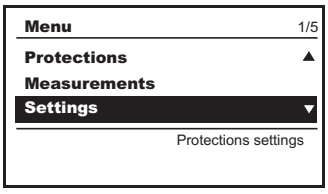
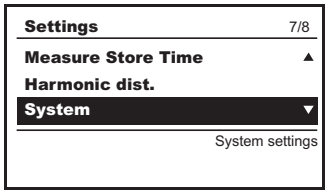
To access the “EDIT” mode, it is necessary to press the ↵ key on a page with fields which can be edited. A password will then be required to enable you to switch to the editing mode.
The use of the keys is summarized in the following table.

Key	Function
	Move between pages Move within menu Change parameter values
	End setting phase and confirm result Choose menu item
	Access to surfing menus from the default page Return to previous level when surfing within the menus, until you return to the default pages Exit the parameter changing phase, aborting the change
	This key is used to re-enable the display after it has gone off within 48 hours of the opening of the circuit-breaker in self-supply mode.

13.4.3. Changing parameter

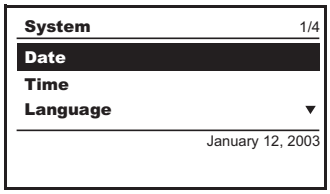
Moving within the Main Menu you can reach all the pages relating to the configurations and parameter settings with the opportunity to change the values specified for the parameters.
After any programming, you need to Confirm/Cancel/Change any changes you have made. This procedure is not applicable to all the programming activities. Two examples are provided below: one concerns the case in which no confirmation is needed for the changes you have made, while in the other a confirmation window appears.

Procedure not requiring the confirmation of any programming
For instance, to set the System Date, the correct sequence is as follows:

From the default page press ESC to access the Main Menu	
From the Main Menu, select SETTINGS press the key ↵ (enter)	
Select SYSTEM press the key ↵ (enter)	

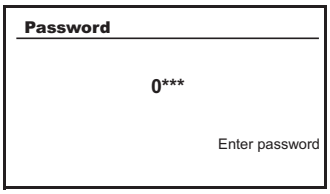
Select the menu item DATE to change

press the key ↵ (enter)



You will be prompted to input a Password
complete the password entry procedure (par.13.3.6)

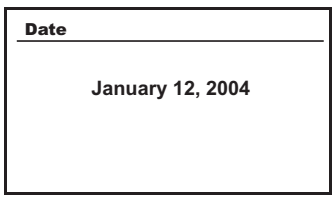
press the key ↵ (enter)



Change the date using the key ↓ (arrow down)

↑ (arrow up) and confirm by pressing the ↵ key (enter).

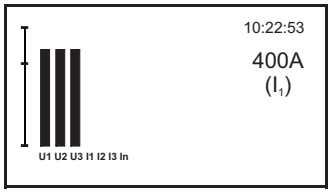
Press ESC twice to return to the Main Menu.



Procedure requiring the confirmation of any programming

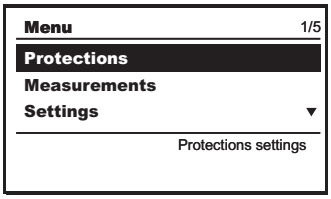
For instance, to change the Curve of the Protection L, the correct sequence is as follows:

From the default page press ESC
to access the Main Menu



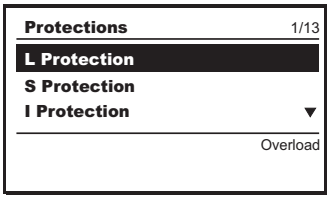
From the Main Menu select the item PROTECTIONS

press the key ↵ (enter)



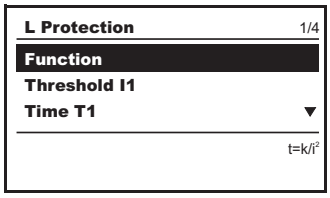
From the Protections Menu select the item PROTECTION L

press the key ↵ (enter)



From the Protection L Menu select the item CURVE

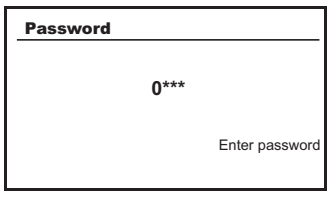
press the key ↵ (enter)



You will be prompted to input a Password (par. 13.3.6)

complete the password entry procedure

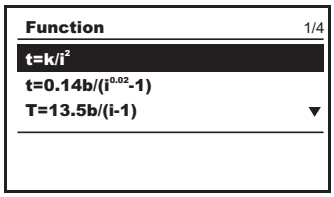
press the key ↵ (enter)



Select the value you want from the list and confirm pressing the ↵ key (enter).

Press ESC twice

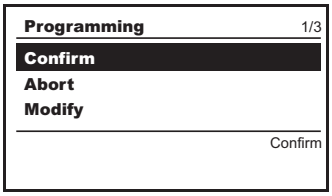
Before accessing the Main Menu, the following box will appear:



Accept the new configuration

Reject the new configuration (the previous configuration is retained)

Change the previously input values.



To select the required option use the ↓ (arrow down), ↑ (arrow up) keys, and press ↵ (enter) to confim.

13.4.3.1. Modification of basic configuration

No parameter settings can be made if the PR122/P unit is in alarm conditions.

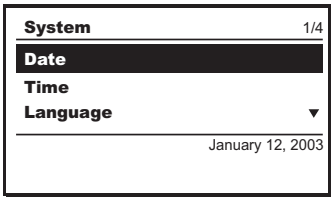
The configuration of the unit must be done in EDIT mode.

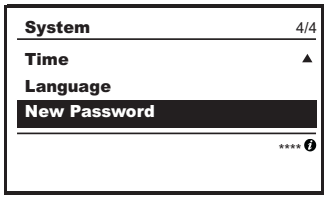
Following the instructions given in par. 13.4.3, view the following on the display:

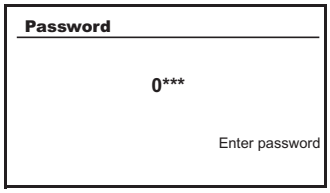
Change system date

Change system time

Select system language







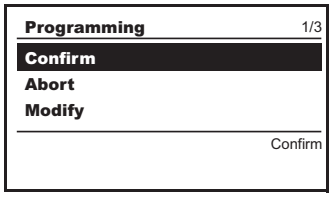
To change the system password, select the relevant menu item and press ↵ (enter); then you will be prompted to enter the OLD password, and afterwards you can input the new one twice.
Press ESC twice to return to the Main Menu.

Before accessing the Main Menu, the following box will appear:

Accept the new configuration

Reject the new configuration (the previous configuration is retained)

Change the previously input values.



To select the required option, use the ↓ (arrow down), ↑ (arrow up) keys, and press ↵ (enter) to confirm.

Note: To set the system language check that:
- the relay is set to local (when PR120/D-M is installed);
- the CB is open;
- auxiliary power supply is connected (Vaux 24VDC and/or busbar voltage through PR120/V and/or PR030/B).
If one of the above conditions is not met, the relay does not allow the language to be changed.

13.4.4. Default settings

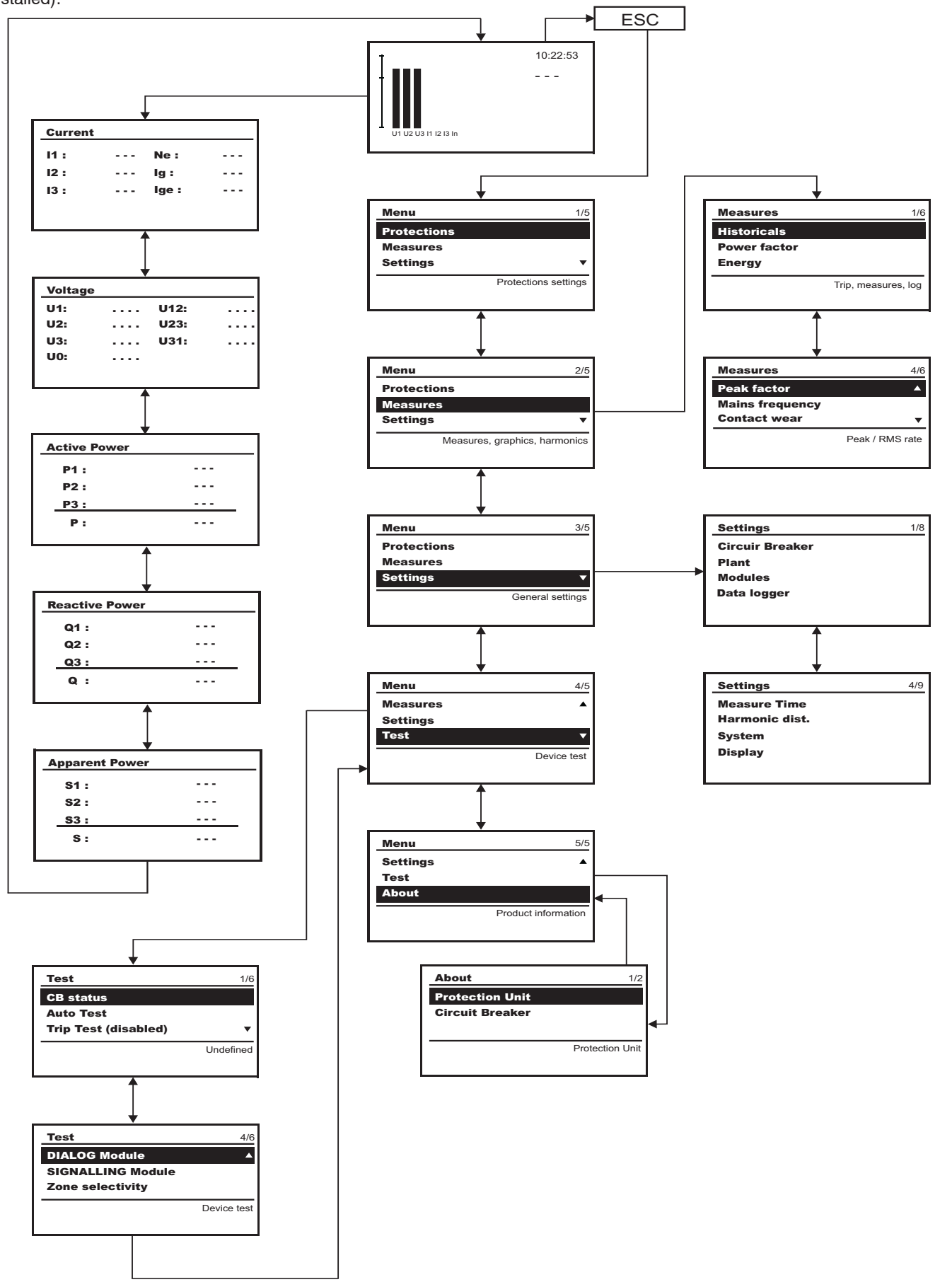
The PR122/P is supplied by ABB SACE with the following predefined parameters:

#	Protection	On/Off	Threshold	Time	Curve	T.M.	ZS	Trip
1	**L**	--	1 In	144 s	I2t	Off	--	--
2	**S**	Off	6 In	50 ms	K	--	Off: 0,04 s	--
3	**I**	On	4 In	--	--	--	--	--
4	**G**	Off	0,2 In	0,4 s	K	--	Off: 0,04 s	On
5	**U (currents)**	Off	50 %	5 s				Off
6	**OT**	--						Off
7	**K LC1**	Off	50 % I1					
8	**K LC2**	Off	75 % I1					
9	**UV**	Off	0.9 Un	5 s				Off
10	**OV**	Off	1,05 Un	5 s				Off
11	**RV**	Off	0,15 Un	15 s				Off
12	**RP**	Off	- 0,1 Pn	10 s				Off
13	**UF**	Off	0,9 Fn	3 s				Off
14	**OF**	Off	1,1 Fn	3 s				Off
15	**Language**	--	Ingl					
16	**Net frequency**	--	50 Hz					
17	**PR021/K**	Off						
18	**Neutral sel.**	--	*					
19	**Toroid sel.**	--	None					
20	**Ext. ground tor.**	Off	100 A					
21	**Rated Voltage**	--	380V					
22	**S startup**	Off	6 In	100 ms				
23	**I startup**	Off	4 In	100 ms				
24	**G startup**	Off	1 In	100 ms				
25	**Password**	--	0001					
26	**Measuring interval**	--	60 min					
27	**Iw**	Off	3 In					
28	**Power direction**	--	top → bottom					
29	**Harmonic distortion warning**	Off						
30	**MCR**	Off	6 In	40 ms	--	--	--	--
31	**Start up activation threshold**		0,1In					

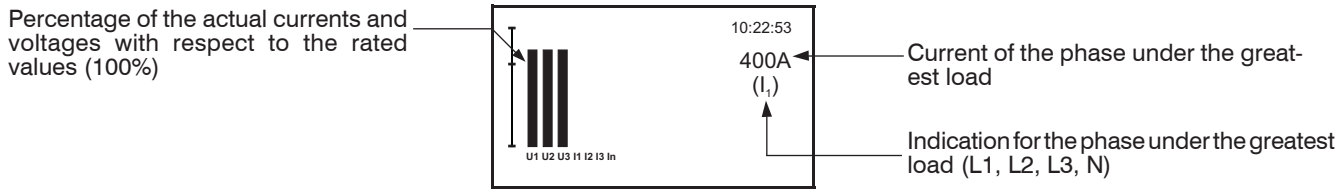
Note:
* = OFF or 3-pole versions
* = 50% or 4-pole versions
* = 100% for full-size versions

13.5.1. Menu

As seen previously, the PR122/P uses the display to show messages, diagrams and menus. These are organized in a logical and intuitive way. The following is a general layout showing how to access the main menu pages in Maximum configuration (PR120/V installed):

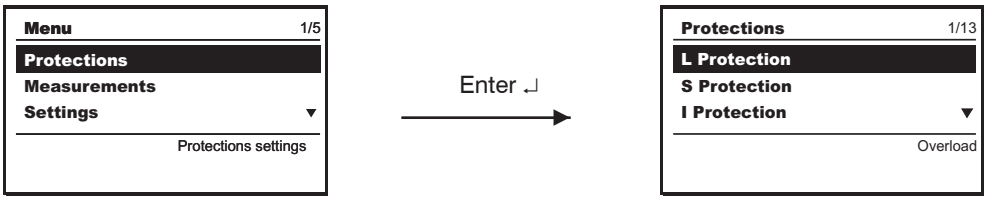


Each time the unit is turned on, or after more than 2 minutes of inactivity on the keyboard, the display indicates the following. page (default):



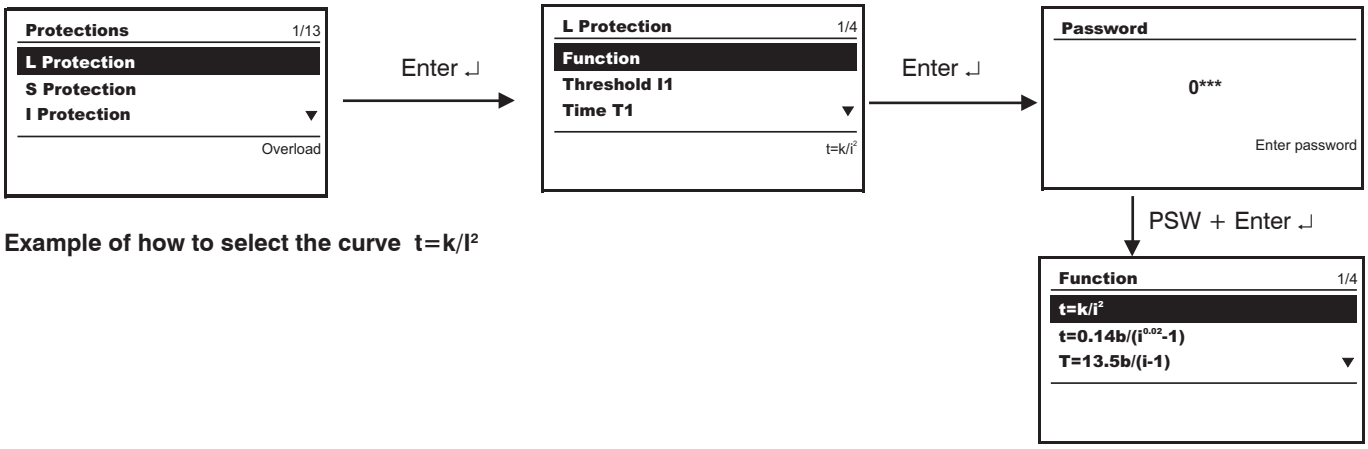
13.5.2. Protections menu

From the interface you can press ENTER to access the menu of the various protections available on the display



Using the “arrow UP” and “arrow DOWN” you can view the various protections.
On the whole, the data that you can display when the optional additional PR120/V module is installed concern the protections: L, S, I, G, Gext, RC, U, UV, OV, RV, RP, UF, OF, OT, LOAD PROTECTION.

Example of surfing the Protections menu
From the Protection main page you can press ENTER to go to the Protection L Menu.
You can use “arrow UP” and “arrow DOWN” to select the items on the menu and confirm by pressing ENTER. Pressing this key triggers a Password prompt, then you can select the functions associated with the protection L (as in the example).



Example of how to select the curve t=k/I²

Similarly, to access the menus for the other protections, see the Protections Menu table below.

13.5.2.1. Protections menu table

Protection	Parameter / Function	
L	Curve	
	Threshold I1	
	Time t1	
	Thermal memory	ON / OFF
S	Enable	ON / OFF
	Curve	
	Threshold I2	
	Time t2	
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
I	Enable	ON / OFF
	Threshold I3	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	

Protection	Parameter / Function	
Gext	Enable	ON / OFF
	Curve	
	Threshold I4	
	Time t4	
	Enable Trip	ON / OFF
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
RC	Threshold I4	
	Time t4	
U	Enable	ON / OFF
	Function	Currents/Voltages
	Threshold I6	
	Time t6	
	Enable Trip	ON / OFF
UV	Enable	ON / OFF
	Threshold U8	
	Time t8	
	Enable Trip	ON / OFF
OV	Enable	ON / OFF
	Threshold U9	
	Time t9	
	Enable Trip	ON / OFF
RV	Enable	ON / OFF
	Threshold U10	
	Time t10	
	Enable Trip	ON / OFF
RP	Enable	ON / OFF
	Threshold P11	
	Time t11	
	Enable Trip	ON / OFF
UF	Enable	ON / OFF
	Threshold f12	
	Time t12	
	Enable Trip	ON / OFF
OF	Enable	ON / OFF
	Threshold f13	
	Time t13	
	Enable Trip	ON / OFF
OT	Enable Trip	ON / OFF
Load Control	Threshold 1	
	Enable	ON / OFF
	Threshold	
	Threshold 2	
	Enable	ON / OFF
	Threshold	
	Threshold Iw	
	Enable	ON / OFF
	Threshold	

Note: for an explanation of the characteristics of the single protections and their settings and corresponding curves, see par. 13.2.9.

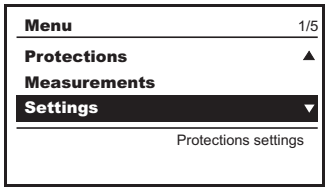
13.5.3. Measurements Menu

For a complete description of the functions of the PR120/V module, see par. 15.1.
The following is a summary of the parameters accessible from the menu in the PR122/P unit.

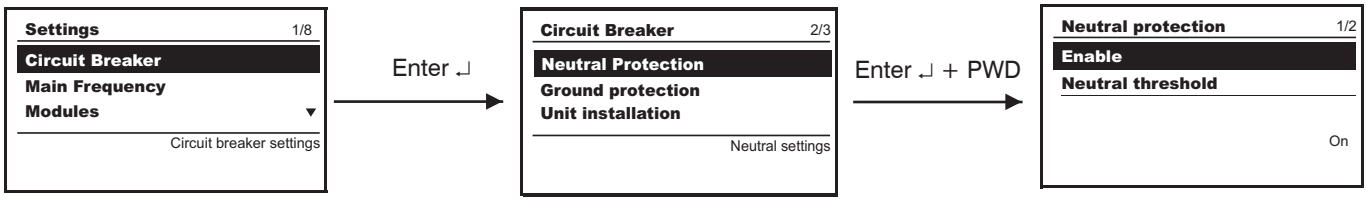
13.5.3.1. Measurements Menu table

Protection	Parameter / Function	Values	Notes
Historicals	Trips		Last trip (20)
	Events		Events log (80 events max.)
	Measurements		
	I Max		Current
	Reset measurements		
Peak factor			
Contact wear			Percentage of wear on CB contacts

13.5.4. Settings Menu



The configuration parameters in the Settings menu are password protected. Among the most significant values you can select, note the neutral threshold (values 50%, 100%, 150%, 200%), the external toroid size (values 100A, 250A, 400A, 800A), the mains frequency at the installation (values 50Hz, 60Hz). For a more detailed description of the settings for the modules, refer to the documentation on the modules (ch. 15).



13.5.4.1. Settings Menu table

	Parameter / Function	Values	Notes
Circuit breaker (*)	Neutral protection		
	Enable	ON/OFF	
	Neutral threshold	50%-100%-150%-200%	
	Ground protection		Said protection is provided only in the event of an external toroid being used
	External toroidal transformer	Absent, SGR, Rc	
	Toroid size SGR		
Mains frequency		50 Hz - 60Hz	
Modules	Module		
	PR120/V - Measuring	if any	see par. 13.5.4.4.1
	PR120/D-M - COM	if any	see par. 13.5.4.4.2
	PR120/K - Signalling	if any	see par. 13.5.4.4.3
	Local Bus unit	Absent - Present	
Data logger	Enable	ON/OFF	
		Sampling frequency	
		Stop event	
		Stopping delay	
		Restart	
		Stop	
Measurement interval		from 5 to 120 min, step 5 min	
Harmonic distortion		ON/OFF	The warning indicates that the distortion exceeds factor 2,1
Sistem	Date		
	Time		
	Language	English/Italiano/Francais/ Deutsch/Español	
	New password		
Display	Contrast		

* With the three-pole circuit breaker, the “3P+N” option is displayed and must be enabled if the outside neutral is installed.

The summary table relates to the surfing of the pages dedicated to the PR120/K module (see par. 15.3) and to the PR021/K unit (see par. 16.1).

13.5.4.2. Neutral adjustment

The neutral protection is normally set to a current value 50% of the adjustment made on the phases.
In some installations, where particularly high harmonics occur, the current circulating on the neutral may be higher than that of the phases.
In the SACE PR122/P release, this protection can be set for the following values:
I_nN= 50% - 100% - 150% - 200% * I_n.

13.5.4.2.1 Neutral adjustment specifications

Neutral (InN) adjustment must meet the following formula: $I_1 \times I_nN \leq Iu$.
In case of a four-pole CB, this setting is checked by the relay which signals any failure through a Led (see par. 13.6.1), and adjusts the parameter independently to the accepted limits.
In case of a three-pole CB with external neutral, the relay performs no checks and user must correct the settings.

E.g.: With CB E1B800 with a 400A Rating Plug, Iu = 800A and I1 = 1In, I_nN adjustment may be: 50-100-200%.
With CB E1B800 with a 800A Rating Plug, Iu = 800A and I1 = 1In I_nN adjustment may be: 50-100%.

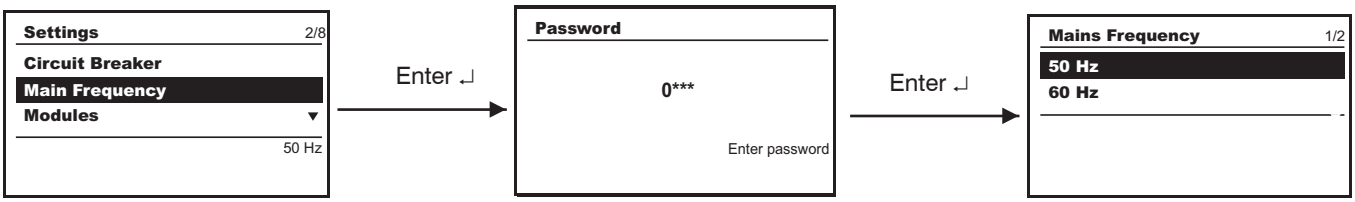
Note 1: $I_1=1I_n$ setting is intended as the maximum adjustment of the protection against overloads. Actual maximum allowable adjustment must take into account any temperature derating, terminals used and altitude, or In (rating plug) ≤ 50% of circuit breaker size.

WARNING: Failure to comply with the setting limits for "I_1" and "I_nN" can cause circuit-breaker damage with consequent risks even for the operator.

In any case, the relay records any setting error between I_1 and the Neutral setting and it signals this by means of the warning (see par. 13.6.3). For four-pole CBs only.

13.5.4.3. Mains frequency settings

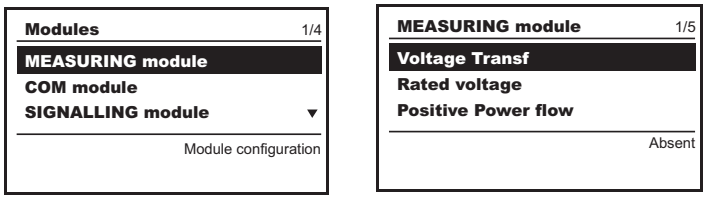
In the mains frequency menu, you can choose between the frequency values: 50, 60Hz.



13.5.4.4. Modules

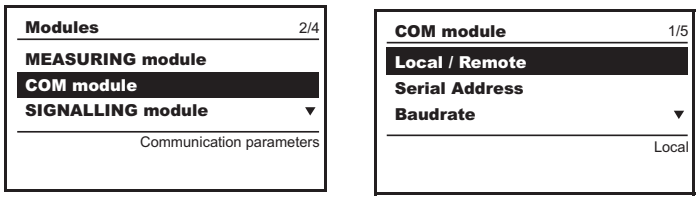
When you access the Settings menu, there is a set of menus available relating to the modules.

13.5.4.4.1 PR120/V MEASURING Module



In the measuring module you must enter a password and can then opt for the absence or presence of the voltage transformer. Moreover, you can select the values of the primary voltage (100, 115, 120, ... 1000V) and secondary voltage (100, 110, ... 230V). The power flow can be LOW → HIGH or HIGH → LOW. After entering a password you can choose whether the neutral connection is to be Absent or Present. For three-pole CBs only

13.5.4.4.2 PR120/D-M - COM module



The local or remote modes can be selected after entering a password. The serial address can be displayed after entering a password. The Baud Rate can be set on the values 9600 and 19200 bit/s. The physical protocol provides for the options: (8,E,1), (8,0,1), (8,N,2), (8,N,1). The addressing can be selected as standard Modbus or ABB. For further information on the PR120/D-M communication module, see paragraph 15.2 in this manual..

13.5.4.4.3 PR120/K - SIGNALLING module

For a thorough examination of the signalling module, refer to the corresponding section of the module, paragraph 15.3.

13.5.4.4.4 PR120/D - BT module

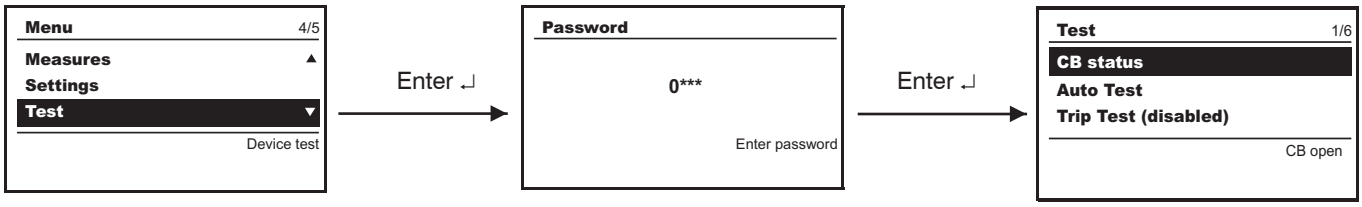
This module is for wireless communication based on the Bluetooth standard between the PR122/P protection release and a laptop with a Bluetooth port. For further information, see the description of the module in paragraph 15.4.

13.5.4.4.5 Settings for the Local Bus unit

If the PR021/K unit is connected, you need to enable the local bus by selecting present.

13.5.5. Test Menu

Access to the Test menu is password protected.



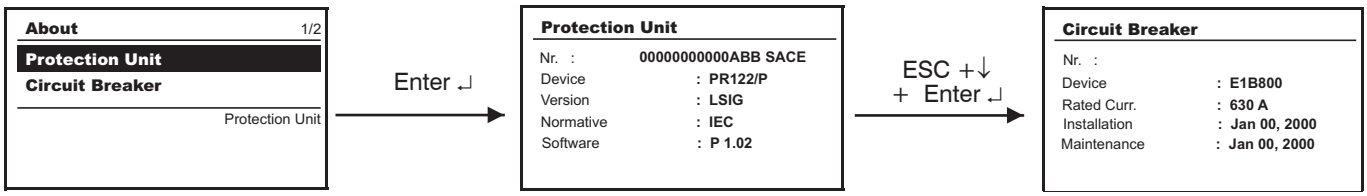
The menu shows the state of the CB, in the dialog module (COM module) the state of the springs and the position of the CB, and in this submenu you can make the CB open or close.
Using the “Trip Test” function lets you view the disabling/enabling of the Trip. If it is enabled, the circuit-breaker is opened. The function is only available with a busbar current of nil (use Vaux, PR030/B or PR010/T).
On the page, only with Vaux, you can also see the state of the circuitbreaker “STATUS”, and thus make sure that the input is correctly wired:
The surfing path is summarized in the following table:

13.5.5.1. Test Menu table

	Parameter / Function	Values	Notes
CB status		Open/Closed/Indefinite	Indefinite in case of fault only
Auto Test			
Trip Test		Enabled/Disabled	
PR120/D-M Module	State of springs	Loaded/Unloaded	
	Position of CB	Isolated/Withdrawn	
	Open CB		
	Close CB		
PR120/K Module	Input	ON	
	Auto Test	- - -	
Zone selectivity	Protection S		
	(status) Input	ON/OFF	
	Force Output		
	Release Output		
	Protection G		
	(status) Input	ON/OFF	
	Force Output		
	Release Output		

13.5.6. Information Menu

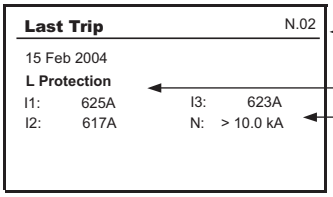
The Information Menu enables you to view the data relating to the protection unit and the type of circuit-breaker.



13.5.6.1. Information on the trip and opening data

The PR122/P unit saves all the information relating to the type of protection tripped, the opening data, the date and time. Using the “i Test” key makes the release show all these data directly on the display. There is no need for an auxiliary power supply for this function. With an auxiliary power supply, the information is shown immediately on the display without the need to press the “i Test” key and remains displayed indefinitely until you press the key.
Information remains available for 48 hours with the relay de-energized. The data relating to the last 20 trips are stored in the unit’s memory. By connecting a PR030/B and PR010/T battery unit or a BT030 USB wireless communication unit, you can retrieve the information relating to the last 20 trips recorded.

Access to view the opening data is via the Historicals submenu in the Measurements menu. The following is an example of the information provided:



Number of openings due to the protections.

Indication for protection tripped.

Value of the currents interrupted on phases (L1, L2, L3), neutral (Ne) and Ground (if G has been tripped).

Again in the Measurements menu, you can view the percentage of contact wear, which is an indication of the electrical life of the electrical contacts in the circuit-breaker.
In any case, functionality of the relay is in no way modified by the presence of the wear messages.
The prealarm message (wear > 80%, “warning” LED lighting up) indicates that the wear has reached a high value. The alarm message (100% wear, “alarm” LED lighting up) indicates that it is necessary to check the state of contact wear.
The percentage of wear depends on the number of openings carried out by the circuit-breaker and by the absolute current interrupted during each of them.

13.6. Definition of alarms and signals in the PR122/P unit

13.6.1. Optical signals

Signaling	Description
Led **Warning** (yellow)	• The prealarm threshold has been exceeded; one or more phases with current values in the range 0.9xI1 < I < 1.05xI1 (on the Ne it depends on the selection made; for instance, at 50% the values are halved). • Presence, between two or three phases, of unbalance above the value programmed for the "U", protection, with protection trip disabled; • Presence of distorted wave form with form factor > 2.1; • ontact wear greater than 80% (and less than 100%); • WARNING Threshold Iw exceeded; • Circuit-breaker state error; • Frequency out of range; • Configuration error; • Settings inconsistency.
Led **Warning** (yellow 0,5Hz)	• Relay’s internal temperature exceeding WARNING threshold.
Led **Warning** (yellow 2Hz)	• Relay’s internal temperature exceeding ALARM threshold.
Led **Alarm** (red)	• Presence of overload on one or more phases with current values I >1.3 I1 (timing protection “L”) (on the Ne it depends on the selection made; for instance, at 200% the values are doubled)*; • Timing in progress for protection function S; • Timing in progress for protection function I; • Timing in progress for protection function G; • Timing in progress for protection function D; • Timing in progress for the voltage (UV, OV, RV), frequency (OF, UF) protection functions; • Timing in progress for the reverse active power protection function (RP); • Timing in the case of unbalance between the phases (protection U) above the value set in the configuration with protection trip set to on; • Contact wear = 100%; • Rating Plug disconnected; • Trip Coil (TC) disconnected; • Key plug error; • Current sensors disconnected; • Installation error.
* The IEC 60947-2 Standard defines the timing threshold L for current: 1.05 < I < 1.3 I1..	

13.6.2. Electrical signals

K51/p1...p4 Programmable electrical signals if the PR120/K module is installed and there is an auxiliary power supply.
K51/p1...p8 Programmable electric signals if the PR021/K unit is installed and there is an auxiliary power supply.
Pressing the “i Test” key enables resetting the activated contacts.

13.6.3. Table of error and warning messages

All the messages which can be shown on the display relating to incorrect configurations, generic alarms or deriving from the protection functions and linked to useful information are described below.

The following symbols in the warning signals have the following meanings:

= Warning signal / Protection in alarm mode, with no trip (trip=off).

=Protection in alarm mode, with trip at end of delay (trip=on)

=Information, no action, excepting displaying by the relay.

Alarm message	Description	Notes
Harmonic dist.	Harmonic distortion alarm	Busbar currents with form factor > 2.1
Contact wear	Alarm for contact wear	Contact wear= 100%
G (TRIP OFF)	Alarm for protection G	
Gext (TRIP OFF)	Alarm for protection Gext	
Alarm T	Alarm for protection T	Temperature outside range
T (TRIP OFF)	Alarm for protection T	
U Alarm	Alarm for protection U	
UV Alarm	Alarm for protection UV	
OV Alarm	Alarm for protection OV	
RV Alarm	Alarm for protection RV	
RP Alarm	Alarm for protection RP	
UF Alarm	Alarm for protection UF	
OF Alarm	Alarm for protection OF	
LC1 Load	Alarm for load control LC1	
LC 2 Load	Alarm for load control LC2	
L1 Sensor	Alarm for L1 phase current sensor	Phase L1 sensor disconnected or faulty
L2 Sensor	Alarm for L2 phase current sensor	Phase L2 sensor disconnected or faulty
L3 Sensor	Alarm for L3 phase current sensor	Phase L3 sensor disconnected or faulty
Ne Sensor	Alarm for Ne phase current sensor	Phase Ne sensor disconnected or fault
Gext Sensor	Alarm for Gext current sensor	Gext sensor disconnected or faulty
Warning signal	Protection in alarm, with no trip (trip=off)	
TC disconnected	Trip Coil disconnected or faulty	
Rating Plug	Rating Plug Error absent or faulty	
Power factor	Alarm for power factor	The power factor module is lower than the specified threshold
Phase cycle	Phase cycle inverted	
Invalid date	Clock information lost	
CB status	CB state error	Probable error in Q26 and/or Q27
Installation	Key Plug Error	
CB not defined	State of circuitbreaker inconsistent (Open/ Closed)	Probable error in Q26 and/or Q27
Local Bus	Local Bus error	See par. 13.7
Contact wear	Contact wear prealarm	Contact wear ≥ 80%
L prealarm	Protection L prealarm	
T prealarm	Protection T prealarm	
Frequency range	Frequency out of range	
Warning Iw	Iw threshold exceeded	
Timing. L	Timing protection L	
Timing. S	Timing protection S	
Timing G	Timing protection G	
Timing Gext	Timing protection local Gext	

Alarm message	Description	Notes
Timing U	Timing protection U	
Configuration	Parameters inconsistency	
Configuration	Relay key plug data inconsistency	
Timing UV	Timing protection UV	
Timing OV	Timing protection OV	
Timing RV	Timing protection RV	
Timing RP	Timing protection RP	
Timing UF	Timing protection UF	
Timing OF	Timing protection OF	

13.6.4. Error messages displayed in pop-up windows

All the messages that appear on the display in a pop-up window are described below.

Error message	Description
Password error	
Session impossible	A programming session cannot be started due to a contingency (e.g. a timer-controlled delay still elapsing)
Value outside range	Value beyond the established limits
Exception 6	Control momentarily unavailable
Unavailable	Function momentarily unavailable
Invalid date	Date and time not updated. Set them.
Parameters revised	Programming session concluded correctly
Cancelled	Programming session cancelled
Failed	Programming session rejected
Failed 1001	Inconsistent protection thresholds(L and S). Set: : $I_1<I_2<I_3$
Failed 1002	Inconsistent protection thresholds (S and I). Set: $I_1<I_2<I_3$
Failed 1009	SdZ incompatible SdZ directional
Failed 3001	Problems with language change
Failed 3002	Problems with toroid RC setting
Failed 3003	Problems with neutral setting

13.7. Troubleshooting PR122/P unit

The following table lists a series of typical service conditions, to help you understand and solve hypothetical faults or malfunctions.

Note:
1. Before consulting the following table, check for any error messages appearing for some seconds on the display.
2. FN indicates the normal operation of the PR122/P.
3. In the case where the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE assistance service

N°	Situation	Possible causes	Suggestions
1	The trip test cannot be run	1. The busbar current is > 0. 2. The TC is not connected 3. CB open	1. FN 2. Check the messages on the display
2	Trip times lower than expected	1. Threshold too low 2. Curve too low 3. Thermal memory enabled 4. Incorrect Neutral Selection 5. The SdZ is inserted	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Correct neutral selection 5. Exclude if not necessary
3	Trip times higher than expected	1. Threshold too high 2. Curve too high 3. Curve I^2t inserted 4. Incorrect Neutral Selection	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Correct neutral selection
4	Rapid trip, with I3=Off	Iinst tripped	FN with short-circuit with high I
5	High earth I, but no trip happens	1. Incorrect selection of the sensor 2. Function G prevented with I>4In	1. Set int. or ext. sensor 2. FN
6	Display off	1. Vaux missing and the current and/or voltages are below the minimum value. 2. Temperature out of range	1. FN, see 13.2.2.1 2. FN, see 13.2.9.8
7	The display is not back-lit	Current and/or volatges below the limit for lighting the display	FN

N°	Situation	Possible causes	Suggestions
8	Reading of V, W and power factor	Current below the minimum threshold that can be displayed	FN
9	Reading of V, W and power factor incorrect	1. Connection error between VT and PR120/V 2. VT parameter settings error	1. Check connections between VT and PR120/V 2. Set the correct parameters
10	"⚠ Local Bus" message on display	No communication between PR122/P and PR021/K	1. If not present, disable PR021/K, see 13.5.4.4.5 2. Check bus connection 3. Check PR021/K
11	Message " " instead of expected data	Function disabled or data or out of range	FN
12	The expected trip does not occur	Trip function disabled	FN enable trip if necessary
13	No activation of the Unbalance U protection	Values of I out of range	FN, see 13.2.9.5
14	No display of the opening data	Vaux missing, the buffer capacitor is discharged	FN, see 13.5.6.1
15	The password is not requested	The password has been disabled	FN, re-enter the password with a value other than 0000.
16	Impossible to change any parameter	PR122/P in alarm situation	FN
17	"⚠ Temp. sensor" or "⚠ Start-up" message	Possible failure inside relay	Contact ABB Sace
18	Invalid date	1. First installation 2. Information lost due to power failure	FN see 13.4.3.1
19	Untimely trip		see 13.6.3
20	Led lighting		see 13.6.1
21	The language cannot be changed	1. The relay is remotely set 2. CB not open 3. Vaux or PR120/V or PR030/B not installed	1. Local settings 2. Open CB 3. Power the relay

13.7.1. In the case of a fault

WARNING: If you suspect that the PR122/P is faulty, if has a malfunction or has generated an unwanted trip, it is advisable to follow the recommendations below very carefully from the Measurements menu ⟶ Historicals ⟶ Trip:

1. Make a note of the type of protection that has tripped by accessing the LAST TRIP page if there is an external power supply (Vaux or battery) or by pressing "i Test" if in self-supply mode.
2. Note down the type of circuit-breaker, number of poles, any accessories connected, In, Serial Number (see par. 13.4) and the SW version.
3. Prepare a brief description of the opening (what LEDs and/or indications were displayed? when did it happen?, how many times ?, was it always under the same conditions? what type of load? what voltage? what current? is the event reproducible?)
4. Send/communicate all the information collected, together with the circuit diagram for the circuit-breaker, to your nearest ABB Customer Support service.

The completeness and accuracy of the information given to the ABB Assistance service will facilitate technical analysis of the problem encountered, and will allow us to carry out all actions useful for the user rapidly.

WARNING: Letting a switch run with a fault that has not been remedied may lead to an apparatus malfunction or shutdown. Remove the apparatus immediately until it can be inspected or repaired if this situation may lead to personal injury, damage or is otherwise critical.

13.8. Accessories

13.8.1. ABB SACE PR010/T test and configuration unit

Testing by the SACE PR010/T unit allows checking correct operation of thresholds and trip times of "L", "S", "I", "G", OV, UV, RV, U protection functions. The test unit is connected to the relay through a dedicated connector (see par. 13.4).

13.8.2. BT030 USB communication unit

Through the BT030 USB wireless communication unit, the PR122/P can be connected via wireless to a PC, extending the information range available to the user.

13.8.3. PR021/K and HMI030 units

The PR122/P can also be connected to the optional external PR021/K unit (see par. 16) to indicate through potential-free power contacts alarms and protection trips, and to the HMI030 switchboard front unit to display a number of information.

13.8.4. PR030/B power supply unit

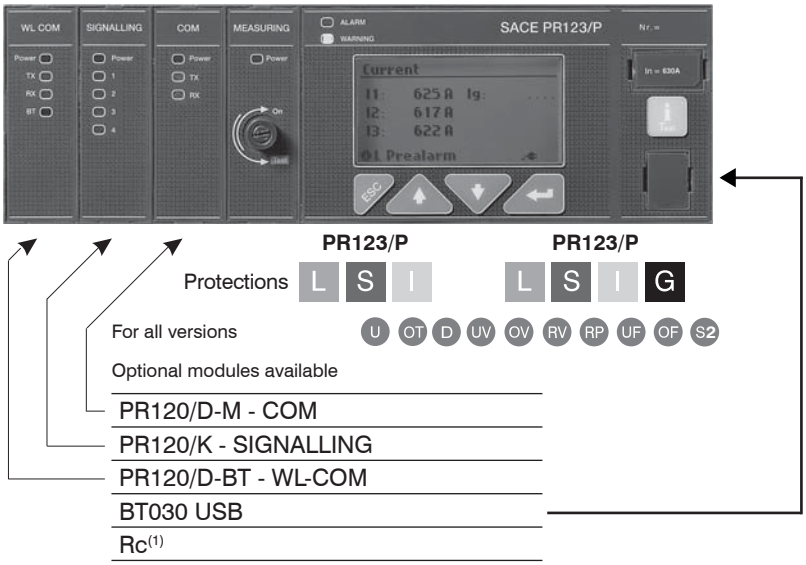
The PR122/P can also be connected to the optional external PR021/K unit (see par. 16) to indicate through potential-free power contacts alarms and protection trips, and to the HMI030 switchboard front unit to display a number of information.

13.8.5. Flex interface

Flex interfaces are electronic modules with analogue and/or digital inputs and outputs that can be fitted on a DIN guide. They can be connected to the supervision system or to the electronic release by internal bus or external bus (see par.16.6).

14. SACE PR123/P Release - Identification

The PR123/P units available, in accordance with the IEC standards, together with the various protections and the various standard and optional modules, are illustrated in the following figure:



Note (1): see par. 16.5

14.1. Standard

The PR123/P has been designed to work in accordance with the international standard:
IEC 60947-2 Low voltage apparatus. Circuit-breakers

14.2. Specifications

14.2.1. General

The PR123/P is a high-performance self-supplied protection unit with **Measurement, Data storage, Communication** (optional), **Self-test, Load control and Zone selectivity** functions for the ABB SACE 'Emax' range of 3- and 4-pole low-voltage air circuit-breakers. The unit's user interface also enables parameter setup and completes the prealarm and alarm management for the protection and watchdog functions.

The protections available are:

Symbol	Protection against
L	overload with inverse long time delay
S, S2	short-circuit with adjustable delay
D	directional short-circuit with adjustable delay
I	instantaneous short-circuit
G	earth fault with adjustable delay
U	phase current unbalance
OT	temperature out of range
UV	undervoltage
OV	overvoltage
RV	residual voltage
RP	reverse active power
UF	underfrequency
OF	overfrequency
MCR	closing on short-circuit

The PR123/P can be installed on 3-pole CBs with and without an external neutral, or on 4-pole CBs.

It should be noted that the reference current for the PR123/P is the In (the rated current defined by the front Rating Plug) and not the Iu (the uninterrupted rated current of the CB itself).
Example: the CB E1B800 with a 400A Rating Plug has an Iu of 800A and an In of 400A.

The unit opens the circuit-breaker in which it is installed by means of the TC, which takes effect directly on the device's mechanical leverism.

The protection unit is self-supplied by current sensors and primary voltages via the PR120/V module.
The unit is made using digital microprocessor technology and interfaces with the user by means of a graphic display and keyboard.

14.2.2. Electrical characteristics

Rated operating frequency	50/60 Hz ±10%
Pass band	2500 Hz max
Peak factor	2,1 @ 2xIn in conformity to IEC 9472 Annex F. For greater peak factors,consult ABB

14.2.2.1. Self-powering

Self-powering enables the protection unit to be powered with the busbar current using current transformers.
Using this supply mode, only the unit's protection functions are assured, however, not the accessory functions regarding the modules.
The characteristics are given in the table below:

General characteristics	Relay Enabling		Relay Activation	
	E1...E3	E4...E6	E1...E3	E4...E6
Minimum three-phase busbar current for enabling relay and switching on the display	>70 A	>140 A	>160 A	>320 A

14.2.2.2. Auxiliary power supply

The external auxiliary power supply is provided using a galvanically-separated power pack.

WARNING: Since the auxiliary voltage needs to be isolated from the ground, "galvanically separated converters" in accordance with the IEC standard 60950 (UL 1950) or the equivalent IEC 60364-41 and CEI 64-8 have to be used to guarantee a current in common mode or leakage current (as defined in IEC 478/1 and CEI 22/3) no greater than 3.5mA.

The presence of the auxiliary power supply enables the relay unit to be used even with the circuit-breaker open, as well as powering all the modules, with the exception of the PR120/V - MEASURING module, which is powered by means of a connection to the busbars.
The characteristics of the power pack are given in the table below.

Characteristics	Version PR123/P
Auxiliary voltage (galvanically separated)	24 V DC ±20%
Maximum ripple	5%
Inrush current @ 24 V	10 A for 5ms
Rated power @ 24 V	2W
Current at pickup @ 24 V with connected modules	15 A for 5 ms
Rated power at pickup @ 24 V with connected modules	6W

14.2.2.3. Powered by the PR120/V module

For a full explanation of the features of the PR120/V, see par. 15.1..

14.2.3. Environmental characteristics

Operating temperature	-25°C ... +70°C
Storage temperature	-40°C ... +70°C
Relative humidity	0% ... 98% with condensation
Degree of protection (with PR122/P installed in the CB).	IP 30

14.2.4. Description of inputs/outputs

14.2.4.1. Binary input

– K51/SZin (K51/DFin):	Zone selectivity: input for protection S or "direct" input for protection D (only with Vaux)
– K51/Gzin (K51/DBin):	Zone selectivity: input for protection G or "reverse" direction input for protection D (only with Vaux)

14.2.4.2. Binary outputs

– K51/SZout (K51/DFout):	Zone selectivity: output for protection S or "direct" output for protection D (only with Vaux)
– K51/GZout (K51/DBout):	Zone selectivity: output for protection G or "reverse" output for protection D (only with Vaux)

14.2.5. Communication bus

Local internal bus on rear connector; RS485 physical interface, Modbus protocol.
External system bus, RS485 physical interface, Modbus RTU protocol, baud rate 9600-19200 bps.
Test bus on front test connector

14.2.6. Protection functions

The PR123/P protection unit carries out 15 independent protection functions. In particular:

1. Protection against overload with inverse time "**L**";
2. Protection against short-circuit with adjustable delay "**S**" and "**S2**";
3. Protection against directional short-circuit with adjustable delay "**D**";
4. Protection against instantaneous short-circuit "**I**";
5. Protection against closing on short-circuit "**MCR**"
6. Protection against earth fault with adjustable delay "**G**";
7. Protection against instantaneous short-circuit at high currents "**I inst**";

8. Protection against phase unbalance “**U**”;
9. Protection against overtemperature “**OT**”;
10. Protection against undervoltage “**UV**”;
11. Protection against overvoltage “**OV**”;
12. Protection against residual voltage “**RV**”;
13. Protection against reverse active power “**RP**”;
14. Underfrequency “**UF**”;
15. Overfrequency “**OF**”.

The PR123/P unit allows current signal processing of the neutral pole with different relationships relative to the value of the phases.
N.B.: Beyond 15.5xIn of current on the Ne, the protection is considered as being set to 100%.

A timing indication (message + “alarm” LED) is provided on the unit’s display, which is activated during a protection alarm. It is disabled when the alarm condition ceases or when the protection has been tripped. When the circuit-breaker opens, the page with the “Trip” data is displayed (when “i Test” is pressed, or automatically in the presence of Vaux).

14.2.6.1. Rms calculation

All the protection functions do their respective processing on the basis of the real rms value of the currents and voltages (the protection G is disabled for current values greater than 8In [where $I_4 \geq 0,8In$], greater than 6In [where $0,5In \leq I_4 < 0,8In$] and greater than 4In [where $I_4 < 0,5In$]).
If the waveform has a deformation beyond the declared limit (see peak factor), the tolerance for the calculation of the true rms value will increase. The UV, OV, RV voltage protections always work on the basis of the true rms value of the voltages.

14.2.6.2. Mains frequency

The PR123/P unit constantly measures the frequency of the mains voltages it is connected to.

If the frequency exceeds the permitted range the “warning” LED comes on and the warning message is displayed (see par. 14.6.3). The signal can be combined with a relay of the optional PR120/K module or with those of the PR021/K unit.

14.2.6.3. Harmonic distortion

The PR123/P unit signals that a peak factor of 2.1 has been exceeded with a warning message and the “warning” LED lighting up (remember that the IEC 60947-2 standard annex “F” establishes that the protection unit must function regularly with a peak factor ≤ 2.1, up to 2xIn).

The signal can be combined with a relay of the PR120/K module or with those of the PR021/K unit.

14.2.6.4. Circuit-breaker state

The PR123/P unit records the state of the circuit-breaker by means of specific wiring on the circuit-breaker. In the case where the presence of current is determined with the circuit-breaker in the “OPEN” state, a state error is signaled by a warning message being displayed (see par. 14.6) and the “warning” LED lighting up.

The signal can be combined with a relay of the PR120/K module or with those of the PR021/K unit.

14.2.7. Measurement functions

The current measuring (ammeter) function is available on all versions of the SACE PR123/P unit.
The display shows histograms with the currents of the three phases and of the neutral on the main page. In addition, the current of the phase under the greatest load is given in numerical form. Where applicable, the earth fault current is displayed on a separate page.
The ammeter functions both in self-powering mode and with an auxiliary supply. In the latter case or in the event of self-powering for 3-phase currents >300A ca. or when the PR120/V module is installed and powered, ammeter and backlighting are always active. The tolerance for the ammeter measuring chain (current sensor plus ammeter) is described in paragraph 14.2.9.16.

The PR123/P release provides a complete set of measurements:
- Currents: three phases (L1, L2, L3), neutral (Ne), earth fault
- Voltage: phase-phase, phase-neutral, residual voltage
- Instantaneous voltage values over a given time interval (data logger)
- Power: active, reactive, apparent
- Power factor
- Frequency and peak factor
- Energy: active, reactive, apparent
- Harmonics calculation: up to the fortieth harmonic (waveform and module of the harmonics displayed); up to the thirty-fifth for frequency f=60Hz
- Maintenance: number of operations, percentage of contact wear, opening data storage.
- Data Logger: see par. 16.3.

The PR123/P can provide the trend of the measurements of certain quantities over an interval P, established by the user; these include: mean active power, maximum active power, maximum current, maximum voltage and minimum voltage. The last 24 P intervals (adjustable from 5 to 120 min) are stored in a non-volatile memory and displayed in a bar graph.
To examine the Measurement functions, see the relevant paragraphs (par. 15.1 and par. 14.5.3) for the PR120/V - MEASURING module.

14.2.8. Watchdog

The PR123/P unit provides some watchdog functions able to guarantee the proper management of relay malfunctions. These functions are as follows:

- ❑ Watchdog for presence of Auxiliary power supply with “plug” icon displayed.
- ❑ RATING PLUG validity.
- ❑ Watchdog for proper connection of the current sensors (CS). If it is enabled, any anomalies are indicated by a special alarm message and the “alarm” LED coming on, and the circuit-breaker opens after 1s.
- ❑ Watchdog for proper connection of the trip coil (TC). If it is enabled, any anomalies are indicated by a special alarm message and the “alarm” LED coming on. If the PR120/D-M module is installed, this activates the coil opening command (YO), thus opening the CB.
- ❑ Watchdog for protection of Hw Trip. If it is enabled, in the event of the sensors being disconnected or a Rating Plug error, a CB opening command is given by the TC being enabled..

14.2.9. Description of the protection functions

14.2.9.1. Protection “L”

The “L” is the only protection that cannot be disabled because it is for self-protection against overloading of the relay itself. The types of trip curves settable are divided into two groups according to the standard they refer to.

Standard trip curve according to IEC 60947-2

Only one type of curve is settable ($t=k/I^2$) as defined by the IEC standard 60947-2.
The protection trip time - inverse time - is given by the expression:

$\frac{9 \cdot t_1}{\left(I_f / I_1\right)^2}$ where $I_f < 12In$, 1 s where $I_f > 12In$ where I_f is the fault current and I_1 the protection threshold.

NB: Time expressed in seconds.

Standard trip curve according to IEC 60255-3

There are 3 types of curves settable, defined by the IEC standard 60255-3 as A, B and C.
The protection trip time - inverse time - is given by the expression:

$t = \frac{k}{(I)^{\alpha} - 1} \bullet b$ where $I = \frac{I_f}{I_1}$ I_f is the fault current and I_1 the protection threshold specified by the user.

NB: Time expressed in seconds.

a and *k* are two parameters, suggested by the standard, which vary the type of slope selected (e.g. for type B slope a=1 and k=13.5);
b is a parameter introduced by SACE to increase the number of curves with the same slope. This parameter is automatically calculated by setting the parameter t1 (required trip time at 3xI1).

14.2.9.1.1 Thermal memory “L”

The thermal memory function can be enabled for cable protection. It is based on the“τL” parameter defined as the trip time of the curve (t1) selected at 1.25xI1. The release trip time is certainly 100% of the one selected, after an interval τL has passed since the last overload or since the last trip. Otherwise, the trip time will be reduced, depending on the overload which has occurred and on the time that has elapsed.

The PR123/P is fitted with two instruments to make up this thermal memory. The first is only effective when the release is powered (it also records overloads that have not lasted long enough to trip the release), while the second works even when the release is not powered, reducing any trip times in the case of an immediate reclosing and is enabled as soon as the CB is tripped.
It is the PR123/P release that automatically decides which of the two to use, according to the various situations.
N.B.: The thermal memory function can only be set if the type of curve selected is the standard one ($t=k/I^2$) (see par. 14.2.9.1).

14.2.9.2. Protection “S”

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/I^2$) type. In the latter case, the trip time is given by the expression

$\text{Max}\left[\frac{100 \cdot t_2}{(I_f)^2}, t_2\right]$ where $I_f > I_2$ where I_f is the fault current and I_2 the protection threshold.

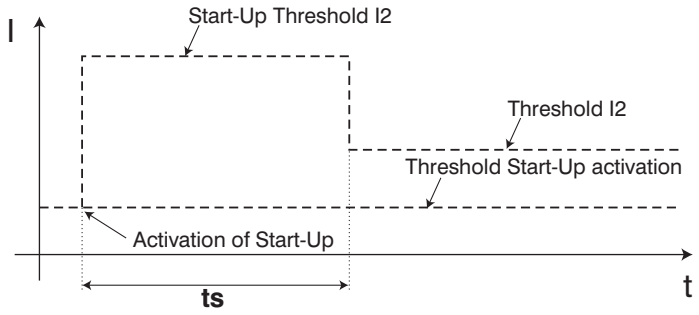
14.2.9.2.1 Thermal memory “S”

The thermal memory function can be enabled for cable protection in the case where the curve with inverse time is selected. This is based on the “tS” parameter defined as the trip time of the curve (t2) selected at 1.5xI2. The other characteristics are the same as those for thermal memory “L” (see par. 14.2.9.1.1).

14.2.9.2.2 Start-up threshold “S”

The start-up function can be selected in the case where the curve with fixed time is selected.
The start-up function can be selected in the case where the curve with fixed time is selected.
The function can be disabled and it is a setting characteristic of the single protection units.
The start-up function enables the protection threshold (S, D, I and G) to be changed during a time interval lasting “ts”, starting from “start-up”. The latter must be intended as follows:

- Passage of at least one of the phase currents above the activation threshold of the adjustable Start-Up with SD TestBus2, Ekip Connect or PR010/T (0.1…10In, by 0.1In steps); A new start-up is possible after the current has dropped below this threshold.

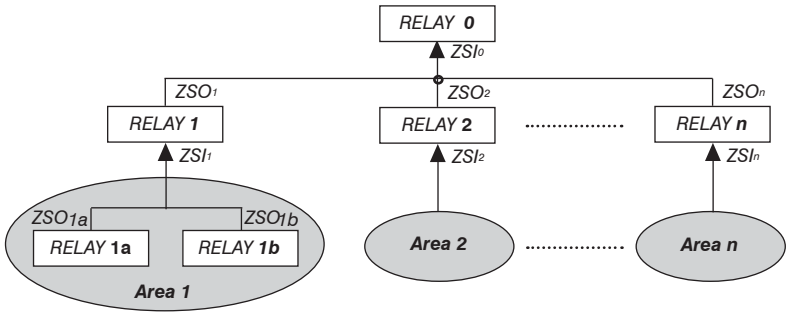


- **Start-up time**

The start-up time is common to all the protections involved.
Range: 0.1s ... 30s, with steps of 0.01s.

14.2.9.2.3 Zone selectivity“S”

The zone selectivity function, guaranteed only if an auxiliary voltage is provided, enables the area of the fault to be isolated, only isolating the part of plant nearest to the fault, while keeping the rest of the plant operational.
This is done by connecting all the zone selectivity outputs of the releases belonging to the same zone to one another (ZSO=K51/SZout) and taking this signal to the zone selectivity input (ZSI=K51/SZin) of the next release on the supply side. If the wiring has been done correctly, all the zone selectivity inputs of the last circuit-breakers in the chain and all the outputs of the circuit-breakers at the head of each chain must be empty.



As a practical example, the figure above shows a fault on the load side of the “Relay 1a” isolated by the latter without the “Relay 1” or the “Relay 0” being affected; a fault immediately downstream from the “Relay 1” will be isolated by the latter without the “Relay 0” being affected, thus ensuring that the Areas 2...n remain operational.

The ZSO output can be connected to a maximum of 20 ZSI relays on the supply side in the selectivity chain.

WARNING: The maximum length of cable for zone selectivity, between two units, is 300 meters.
Use corded shielded two-wire cable (see note A to par. 11.2.2).
The shield must only be earthed on the circuit-breaker of the supply-side relay (ZSI side).

Wiring and enabling zone selectivity “S” is an alternative to using protection “D” and operation is only guaranteed when there is an auxiliary voltage.
The following logical table is implemented to manage the Zone Selectivity Input (ZSI) and Zone Selectivity Output (ZSO) signals:

Zone selectivity	$I_f > I_2$	ZSI signal	ZSO signal	Trip T
Escluded	NO	0	0	No trip
Escluded	NO	1	0	No trip
Escluded	YES	0	0	t_2 programmed
Escluded	YES	1	0	t_2 programmed
Inserted	NO	0	0	No trip
Inserted	NO	1	1	No trip
Inserted	YES	0	1	$t_{selectivity}$
Inserted	YES	1	1	t_2 programmed

The time t_2 must be set at a value corresponding to at least $t_{selectivity}$ +50ms, on CB on supply side, not required on the first one in the chain.

14.2.9.3. Double S

Thanks to the new PR123/P release that enables two independent and simultaneously active protection S thresholds to be specified, selectivity can assured even in critical conditions.
This function enables a better selectivity level to be obtained than using a release without a “double S”. This function is valid for t=K only.

14.2.9.4. Directional Protection “D”

The PR123/P unit carries out excludable directional protection against short-circuit with adjustable fixed time (t = k) active both with self-powering and with auxiliary supply..

The protection functionality is very similar to protection “S” with fixed time, with the capacity to recognize the current direction during the fault period as well.
The direction of the current enables the determination of whether the fault is on the supply side or the load side of the circuit-breaker. Especially in ring distribution systems, this enables the distribution stretch where the fault occurred to be identified and isolated without interfering with the rest of the installation (using zone selectivity).
To determine the direction of the current, the value of the phase reactive powers has to be higher than 2% of the nominal phase power

$(P_Q \geq 2\% \cdot P_{nphase})$.

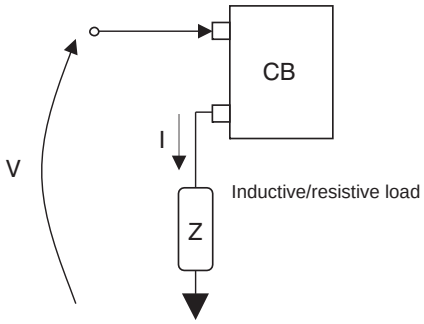
The PR123 enables you to define the power flow in the circuit-breaker from the menu:
from high to low (Top → Bottom),
from low to high (Bottom → Top),
selectable in the menu Modules Measuring Module (PR120/V).

As a result, the currents in the circuit-breaker will be defined as “forward” or “backward” if their are in phase or out of phase with the previously-defined power flow (for the default setting, see par. 14.4.4).

In short:

Ifault (I_f)		Power flow set Top → Bottom	Power flow set Top → Bottom
Value	**Direction**	**Trip T**	**Trip T**
$I_f < I_7$	Either	No trip	No trip
$I_f > I_7$	High → Low	t_{7FW}	t_{7BW}
$I_f > I_7$	Low → High	t_{7BW}	t_{7FW}

Example:
Once the power flow has been set as “Top → Bottom”, the direction of the figure alongside is:



positive reactive power in → “forward” direction;;

negative reactive power in → “backward” direction

If the preset trip times were t_{7FW} = 200 ms and t_{7BW} = 400 ms, in this case the relay would have opened the circuit-breaker after t_{7FW} = 200 ms.

Note:
- With the directional protection D activated, if the direction of the power cannot be determined the relay takes effect considering shorter of the programmed times between $t_7$fw and $t_7$bw.
- This protection works on the basis of the phase currents, not the neutral current.

14.2.9.4.1 Start-up threshold “D”

The function can be enabled from the menu (see description of the protection menu 14.5.2)
The function behaves in exactly the same way as the protection “S” (see par. 14.2.9.2.2).

14.2.9.4.2 (Directional) zone selectivity “D”

The Directional Zone Selectivity (SdZ D) function is particularly useful in ring and grid type systems where, in addition to the zone, it is essential to define the direction of the power flow that powers the fault.

The SdZ D can be set as an alternative to Zone Selectivity S and G and requires an auxiliary power supply.

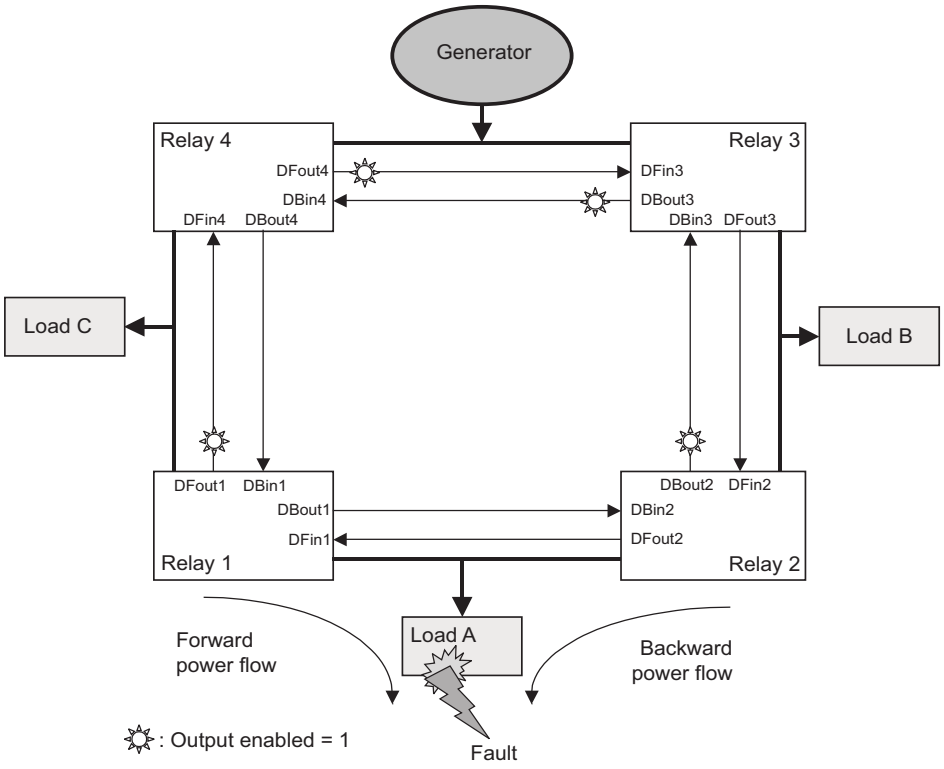
To define the zone and power flow, each relay has two inputs (DFin and DBin) and two outputs (Dfout and DBout), which must be suitably connected to the other relays (see example below).
As in the SdZ S and G, the relays interact with each other, sending cutout signals via the outputs and reading them via the inputs.

The general behavior is summarized in the table below.
(Example with power flow setting “Top → Bottom”).

Ifault (I_f)		Outputs status		Inputs status		T trip
Value	**Direction**	**DFout**	**DBout**	**DFin**	**DBin**	
$I_f < I_7$	either	0	0	either	either	No trip
$I_f > I_7$	Top → Bottom	1	0	0	either	t_s
$I_f > I_7$	Top → Bottom	1	0	1	either	t_{7FW}
$I_f > I_7$	Bottom → Top	0	1	either	1	t_{7BW}
$I_f > I_7$	Bottom → Top	0	1	either	0	t_s

If the power flow is in phase with the direction set on the relay, the output DFout is enabled (1).
Vice versa, if the power flow is out of phase, the output DBout is enabled (1).

The typical configuration of the system of circuit-breakers for which the SdZ D is likely to be used is the sort of ring illustrated in the following figure.



If a fault is detected (I fault If beyond the threshold I7) in one of the sections of the system (Load A), the final circuit-breakers for the section in question (Relay1 and Relay2) communicate the presence of the fault to the connected circuit-breakers (Relay4 and Relay3) by setting the output signals DFout or DBout depending on the direction of the current (DFout1=On, DB2out=On). To be more precise, the circuit-breakers that limit the section affected by the fault see the direction of the fault current in different ways (Relay1=forward and Relay2=backward).

The circuit-breakers (Relay1 and Relay2) delimiting the section affected by the fault are tripped with the selectivity time ts, while the circuit-breakers further away from the fault count down the time t7FW (Relay4) and t7BW (Relay3) without opening; in this way, the system is isolated, in the time ts, to exclude the part affected by the fault.
The load A, where the fault has occurred, will be disconnected, but loads B and C will continue to be powered normally.

It should be noted that activation of the DBout3 output by the relay3 will have no effect on the relay4, because the latter is recording not an out-of-phase (backward) fault current, but an in-phase (forward) current with the power flow defined previously by the user (Top → Bottom).

Note:
- With zone selectivity enabled, if the direction of the power flow cannot be ascertained, the relay is tripped considering the lesser of the programmed times between t7fw and t7bw, without enabling any outputs (DFout or DBout).
- If, for some reason, one of the circuit-breakers required to open does not do so, a specific function will activate the opening of the first circuit-breaker immediately upstream from it, after a further 100ms approx. In the above example, if the circuit-breaker does not open with the relay1, only the circuit-breaker with relay4 will open after a time ts+100ms.
- The SdZ D operates on the basis of the phase currents, not of the neutral.

14.2.9.5. Protection “I”

The protection is enabled/disabled from the menu.
In the case where zone selectivity “S” is active, during the trip of the relay for “I”, the ZSO output signal is activated in any case to guarantee correct operation of the relay on the supply side (and on the load side).

14.2.9.5.1 Start-up threshold "I"

The start-up function can be selected.
The function can be enabled from the menu on the protection "I" page.
The function behaves in exactly the same way as the protection "S" (see par. 14.2.9.2.2).

14.2.9.6. Protection against closing on short-circuit "MCR"

The MCR function is used to protect the system against closing.
If activated (the protection can be enabled/disabled), it operates only in the presence of Vaux or PR120/V, and with Protection "**I**" disabled.
The MCR function has the same functional characteristics as protection "I" (it uses the same control or trip algorithm), and starts operation only when the CB closes, with a time window of 0 to 40…500ms (settable by the user), after which it is deactivated.
The time window and threshold settings are set by the user.
This function can be activated through a hand-held PR010/T unit with the ABB SD-Testbus2 communication softwares or through a remote system via a system bus.
Protection "S" protects against short circuits.

14.2.9.7. Protection "G"

This protection can be disabled; it can be of the fixed time (t=k) or inverse time ($t=k/I^2$) type. In the latter case, the trip time is given by the expression

Max $\left(\frac{2}{I^2}, t_4\right)$ where $I=I_f/I_4$, I_f is the fault current and I_4 is the protection threshold.

NB: Time expressed in seconds.

WARNING: It is possible to disable the trip control of the protection ("Enable Trip: Off").
For the whole duration of the earth fault, circuit-breaker opening does not take place, but only the alarm condition is signaled ("Alarm" LED lit and alarm message).

The PR123/P unit can provide two different types of earth fault protection, **simultaneously**:

Internal protection G
This is provided inside the release by vectorially summing the phase and neutral currents. The fault current is defined by the following formula:

$$\vec{I}_G = \vec{I}_1 + \vec{I}_2 + \vec{I}_3 + \vec{I}_N$$

In the case when the circuit does not show any fault, the module of the sum of these currents is always nil; vice versa the value of the fault current will take on an increasingly large value depending on the size of the fault. This operating mode is enabled by default.
N.B.: it can be used also with CS for an external neutral.

Protection G with external toroid "Source Ground Return"
Also called "Source Ground return", this can be carried out when there is the need to check operation of a machine (transformer, generator or motor etc.) which has star-configured windings.
The protection is assured by physically positioning an external toroid on the cable connected from the star center of the machine to the earthing connection point.
The induced current on the winding of the toroid is proportional to the fault current which, in this case, only transits in the above-mentioned toroid.
To work in this mode, "Ground protection" must be selected on the Circuit-breaker Settings menu.

WARNING: The external toroid must be connected to the PR123/P by means of a corded shielded two-wire cable (see note A in par. 11.2.2) with a length not exceeding 15m.
The shield must be earthed both on the circuit-breaker side and on the toroid side.

It is indispensable for the star center to be connected openly to earth and for it not to be used as a neutral conductor too (as in the TNC system), making a protection according to the TT system.
The protections G and Gext can be enabled simultaneously. The minimum allowable threshold for the Gext protection is 0.1 x In (where In is the rated current of the homopolar toroidal transformer; the In settings available are 100, 250, 400, 800A).

14.2.9.7.1 Start-up threshold "G"

The start-up function can be selected in the case where the curve with fixed time is selected.
The function can be enabled and disabled on the protection "G" page.
The function behaves in exactly the same way as the protection "S" (see par. 14.2.9.2.2).

14.2.9.7.2 Zone selectivity "G"

The zone selectivity function can be enabled providing the fixed time curve, the wiring and the zone selectivity "G" enabling alternative to the one for "D" have been selected and the function is assured only if auxiliary voltage is provided.

Zone selectivity "G" can be active at the same time as zone selectivity "S".
The behavior and wiring of the function are identical to those indicated for zone selectivity "S" (see par. 14.2.9.2.3).

14.2.9.8. Protection against phase unbalance "U"

The protection with fixed time, which can be excluded, trips in the case when, for a time greater than or the same as the time **t6** set, an unbalance is determined between two or more phases higher than the set threshold **I6**. Range: 2 … 90%, by 1% step.
The percentage of unbalance is therefore calculated

$\%\ Unb = \frac{I_{max} - I_{min}}{I_{max}} \cdot 100$ where I_{max} is the maximum and I_{min} is the minimum phase current.

Note: alternatively to the "U" current unbalance protection

WARNING: It is possible to disable the trip control of the protection ("Enable Trip: Off").
In that case, for the whole duration of the unbalance the CB will not be opened, but only the condition will be signaled by means of the "warning" LED lit up and a warning message.
When the value of the phase current is above 6xIn, the function "U" excludes itself because, in this case, the other protections intervene because the fault is considered as a phase fault.
The protection is not enabled for maximum phase current values lower than 0.3xIn.

14.2.9.9. Protection against overtemperature inside the relay "OT"

There is a sensor inside the PR123/P unit that monitors the temperature of the unit.
This enables the signalling of any abnormal temperature conditions, which could cause temporary or continuous malfunctions of the unit's electronic components.

This protection has two states of operation:

State of **"WARNING TEMPERATURE"** with ***–25°C < temp. < -20°C*** *or* ***70°C < temp. < 85°C*** : the display is turned off and the "WARNING" LED flashes at 0.5Hz

State of **"ALARM TEMPERATURE"** with ***temp. < –25°C*** or ***temp. > 85°C*** : the display is turned off, the "WARNING" and "ALARM" leds flash at 2Hz and Trip is activated (if enabled by means of the "Over Temper. Trip = On" parameter).

N.B.:
- In the event of Warning and Alarm, the display is momentarily turned off, to preserve its functionality.
- The monitored temperature is not visible on the display.

The protection is always active, both with auxiliary supply and in self-powering.

WARNING: Disabling the Trip control of the protection means that the PR123/P unit could work, with the circuit-breaker closed, in a range of temperatures where correct operation of the electronics is not guaranteed.

14.2.9.10. Load control function

Single loads can be enabled/disabled on the load side before the overload protection L intervenes and trips the circuit-breaker on the supply side. This is done by contactors or switch-disconnectors (wired outside the release), controlled by the PR123/P by means of contacts on the PR120/K module or on the PR021/K external unit.

The current thresholds are lower than those available with the protection L, so that the load control can be used to prevent tripping due to overloads. The function is active when an auxiliary power supply or power by PR120/V module is present (see par. 15.1.4). The operating logic involves the activation of three contacts when the preset thresholds LC1, LC2 and Iw are exceeded. Thresholds LC1 and LC2 are expressed as a percentage of I1 (current threshold specified for protection L) while the "warning current" Iw is expressed as an absolute value. The allowable values are given in the following table:

Threshold LC1	50%...100% x I1 step 1% I1
Threshold LC2	50%...100% x I1 step 1% I1
Threshold Iw	0,3 ...10,0 x In step 0,05 In

From the PR123/P you can associate each of the PR120/K or PR121/K contacts with a configuration (NO or NC), a delay and any latch.

14.2.9.11. Voltage protections "UV", "OV", "RV", "U"

The PR123/P unit provides 4 voltage protections, which can be disabled, with fixed adjustable time (t = k), active both with self-powering and with auxiliary supply:
- Undervoltage "UV"
- Overvoltage "OV"
- Residual voltage "RV"
- Unbalance of line voltage "U".

The protections work on the line voltages. The threshold voltages indicated refer to the line voltage.

Apart from the normal timing and "TRIP" operation, the voltage protections can be in a state defined as "alarm" (with the "emergency" led on and an alarm message displayed) providing there is an auxiliary or PR120/V module power supply. In fact, in the case where the circuit-breaker is open and no current is detected, the timing leads to the "alarm" state and not to "TRIP". This is because the fault linked to the voltages can persist even with the circuit-breaker open and the unit would therefore always be under "timing". When the circuit-breaker is closed or the passage of a current is detected, you pass immediately from the state of "alarm" to "TRIP" without timing (see par. 14.3.2).

14.2.9.11.1 Protection "UV"

When the minimum phase voltage drops below the set threshold U_8 the protection counts down the preset time interval t_8 and then opens.

14.2.9.11.2 Protection "OV"

When the maximum phase voltage exceeds the set threshold U_9 the protection counts down the preset time interval t_9 and then opens.

14.2.9.11.3 Protection "RV"

When the residual voltage exceeds the set threshold U_{10} the protection counts down the preset time interval t_{10} and then opens. The residual voltage U_0 is calculated by vectorially summing the phase voltages. It is therefore defined by the following formula:

$$\overrightarrow{U_0} = \overrightarrow{U_1} + \overrightarrow{U_2} + \overrightarrow{U_3}$$

14.2.9.11.4 Protection "U"

The disable-type, fixed-time protection trips when – for a time higher or equal to time **t6** set – an unbalance is detected between two or more line voltages higher than the set **I6** threshold. Range: 2 … 90% by 1% steps.

The percentage of unbalance is therefore calculated $Voltage\ unbalance = \frac{Max.\ deviation\ from\ mean\ d_i\ (V_{12}, V_{23}, V_{31})}{Mean\ d_i\ (V_{12}, V_{23}, V_{31})}$.

Note: alternatively to the "U" current unbalance protection.

14.2.9.12. Protection against reverse active power "RP"

The PR123/P unit provides protection (which can be disabled) with an adjustable fixed time (t = k), against reverse active power, active both with self-powering and auxiliary supply.
When the total reverse active power (sum of the power of the 3 phases) exceeds the set reverse active power threshold P_{11} the protection counts down the preset time interval t_{11} and then opens.
The minus sign ('-') in front of the threshold and power indicates reverse power. The threshold is indicated as a percentage of "Pn", where "Pn" is the nominal power of the circuit-breaker (3 Vn*In).

14.2.9.13. Frequency protections "UF", "OF"

The frequency protections record the mains frequency variations above an adjustable threshold (f_{12}, t_{12}) or below (f_{13}, t_{13}), generating an alarm or the opening of the circuit-breaker.

14.2.9.14. Double protections setting

Using the double protections setting, the PR123/P can save a set of alternative parameters for all the protections. The second set of parameters (set B) can replace the default set (set A) by means of an external command. The passage from set A to set B can be made when there is a change in the mains configuration or when there is an emergency capable of changing the load capacity and the short-circuit levels.

The second set of parameters (set B) can be enabled by:
- digital input provided with the PR120/K module. For instance, it can be connected to an auxiliary contact of a bus-tie;
- communication network, by means of the PR120/D-M (e.g. when the switch is scheduled);
- directly from the user interface on the PR123/P (see settings menu par. 14.5.4);
- with a time that can be specified by set A or set B after the circuit-breaker has closed;
- depending on a Vaux being installed.

In operation, the state (set A and set B) is indicated on the display.
The double setting is disabled by default. To enable it, see par. 14.5.4.1.

14.2.9.15. Summary table of the protection function settings for the PR123/P

Protection	Disabling	Disabling TRIP only	Zone selectivity	Start-up threshold	Thermal memory	Threshold range	Time range	Threshold tolerance (2)	Time Tolerance (2)
L ($t=k/I^2$) curve IEC 60255-3	☐	☐	☐	☐	☒	0,4xIn $\le I_1 \le$ 1xIn step 0,01xIn	3 s $\le t_1 \le$ 144 s(1), step 3 s @If=3I_1	Release between 1,05 e1,2 xI1	± 10%, $I_f \le$ 6In ± 20%, $I_f >$ 6In
S_1 ($t=k$)	☒	☐	☒	☒	☐	0,6xIn $\le I_2 \le$10xIn step 0,1xIn 0,6xIn $\le I_{2\ start\text{-}up} \le$10xIn step 0,1xIn	$I_f>I2$ 0,05 s $\le t_2 \le$ 0,8 s, step 0,01s 0,10 s $\le t_{2\ start\text{-}up} \le$ 30 s, step 0,01s 0,04 s $\le t_{2\ sel} \le$ 0,20 s, step 0,01s	± 7%,$I_f \le$ 6 In ± 10%,$I_f >$ 6 In	The best of the two data ± 10% o 40 ms
S_1 ($t=k/I^2$)	☒	☐	☐	☐	☒	0,6xIn $\le I_2 \le$10xIn step 0,1xIn	0,05 s $\le t_2 \le$ 0,8 s, step 0,01 s @I_f=10In	± 7%,$I_f \le$ 6 In ± 10%,$I_f >$ 6 In	± 15%, $I_f \le$ 6In ± 20%, $I_f >$ 6In
S_2 ($t=k$)	☒	☐	☒	☒	☐	0,6xIn $\le I_2 \le$10xIn step 0,1xIn	@$I_f>I_2$ 0,05 s $\le t_2 \le$ 0,8 s, step 0,01s 0,10 s $\le t_{2\ start\text{-}up} \le$ 30 s, step 0,01s 0,04 s $\le t_{2\ sel} \le$ 0,40 s, step 0,05s	± 7%,$I_f \le$ 6 In ± 10%,$I_f >$ 6 In	The best of the two data ± 10% o 40 ms
D ($t=k$)	☒	☐	☒	☒	☐	0,6xIn $\le I_7 \le$10xIn step 0,1xIn	@$I_f>I_7$ 0,20 s $\le t_7 \le$ 0,8 s, step 0,01s 0,10 s $\le t_{7\ start\text{-}up} \le$ 30 s, step 0,01s 0,13 s $\le t_{7\ sel} \le$ 0,50 s, step 0,01s	± 10%	The best of the two data ± 10% o 40 ms
I ($t=k$)	☒	☐	☐	☒	☐	1,5xIn $\le I_3 \le$15xIn step 0,1xIn 1,5xIn $\le I_{3\ start\text{-}up} \le$15xIn	$\le$ 30 ms 0,10 s $\le t_{3\ start\text{-}up} \le$ 30 s, step 0,01 s @ $I_f>I_3$	± 10%	
MCR ($t=k$)	☒	☐	☐	☐	☐	6,0xIn $\le I_5 \le$15xIn step 0,1xIn	@$I_f>I_5$ $\le$ 30 ms(3)	± 10%	
G(4) ($t=k$)	☒	☒	☒	☒	☐	0,20xIn $\le I_4 \le$1xIn step 0,02xIn	0,1 s $\le t_4 \le$ 1 s, step 0,05 s 0,1 s $\le t_{4\ start\text{-}up} \le$ 1 s, step 0,02 s 0,04 s $\le t_{4\ sel} \le$ 0,2 s, step 0,01 s @ $I>I_4$	± 7%	The best of the two data ± 10% o 40 ms
G(4) ($t=k/I^2$)	☒	☒	☐	☐	☐	0,20xIn $\le I_4 \le$1xIn step 0,02xIn 0,2xIn $\le I_{4\ start\text{-}up} \le$1x$I_4$	0,1 s $\le t_4 \le$ 1 s, step 0,05 s (minimum trip time) @I_f>4In	± 7%	± 15%
Gext ($t=k$)	☒	☒	☒	☒	☐	0,20xIn $\le I_4 \le$1xIn step 0,02xIn	@$I_f>I_4$ 0,1 s $\le t_4 \le$ 1 s, step 0,05 s 0,1 s $\le t_{4\ start\text{-}up} \le$ 30 s, step 0.02 s 0,04 s $\le t_{4\ sel} \le$ 0,2 s, step 0,01 s	± 7%	The best of the two data ± 10% o 40 ms
Gext ($t=k/I^2$)	☒	☒	☐	☐	☐	0,20xIn $\le I_4 \le$1xIn step 0,02xIn	0,1 s $\le t_4 \le$ 1 s, step 0,05 s (minimum trip time) @I_f>4In	± 7%	± 15%
Rc(6) (Idn)	☐	☐	☐	☐	☐	Idn =3,0-5,0-7,0-10-20-30A	0,06-0,10-0,20-0,30-0,40-0,50-0,80s(3)	-20% ÷ 0	0,06s(5)

Protection	Disabling	Disabling TRIP only	Zone selectivity	Start-up threshold	Thermal memory	Threshold range	Time range	Threshold tolerance (2)	Time Tolerance (2)
U (t=k)	☒	☒	☐	☐	☐	2% ≤ I_6 ≤ 90% step 1%	0,5 s ≤ t_6 ≤ 60 s, step 0,5 s	± 10%	The best of the two data ± 10% o 40 ms
OT (temp=k)	☐	☒	☐	☐	☐	Fixed, defined by ABB SACE	Instantaneous	± 5°C	
Iinst	☐	☐	☐	☐	☐	Automatic, defined by ABB SACE	Instantaneous		
UV (t=k)	☒	☒	☐	☐	☐	0,5xUn ≤ U_8 ≤ 0,95xUn step 0,01xUn	0,1 s ≤ t_8 ≤ 5 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
OV (t=k)	☒	☒	☐	☐	☐	1,05xUn ≤ U_9 ≤ 1,2xUn step 0,01xUn	0,1 s ≤ t_9 ≤ 5 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
RV (t=k)	☒	☒	☐	☐	☐	0,1xUn ≤ U_{10} ≤ 0,4xUn step 0,05 Un	0,5 s ≤ t_{10} ≤ 30 s, step 0,5 s	± 5%	The best of the two data ± 10% o 40 ms
RP (t=k)	☒	☒	☐	☐	☐	- 0,3xPn ≤ P_{11} ≤ -0,1xPn step 0,02 Pn	0,5 s ≤ t_{11} ≤ 25 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
UF	☒	☒	☐	☐	☐	0,9fn ≤ f_{12} ≤ 0,99fn step 0,01 fn	0,5 s ≤ t_{12} ≤ 3 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
OF	☒	☒	☐	☐	☐	1,01fn ≤ f_{13} ≤ 1,1fn step 0,01 fn	0,5 s ≤ t_{13} ≤ 3 s, step 0,1 s	± 5%	The best of the two data ± 10% o 40 ms
LC1/LC2 loads control	☒	☐	☐	☐	☐	50%÷100% step 1%xI_1			
Warning Iw	☒	☐	☐	☐	☐	0,3÷10I_n step 0,05xI_n		± 10%	10÷40 ms

(1) The minimum value of this trip is 1s regardless of the type of curve set (self-protection).

(2) These tolerances are based on the following assumptions:
- Self-powered relay (no start-up) with 2 or 3 supplied phases and/or in presence of auxiliary supply.
- preset trip time ≥ 100 ms.

(3) no-trip time.

(4) the protection G is disabled for current values greater than 4In, where I4 < 0.5 In, greater than 6 In, where 0.5 In ≤ I4 < 0.8 In and greater than 8 In where I4≥ 0.8 In.

(6) See paragraph 16.5.

For all cases not covered by the above hypotheses, the following tolerance values apply:

Protections	Trip threshold	Trip time
L	Release between 1,05 e 1,25 x I1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 10%	± 20%
Others		± 20%

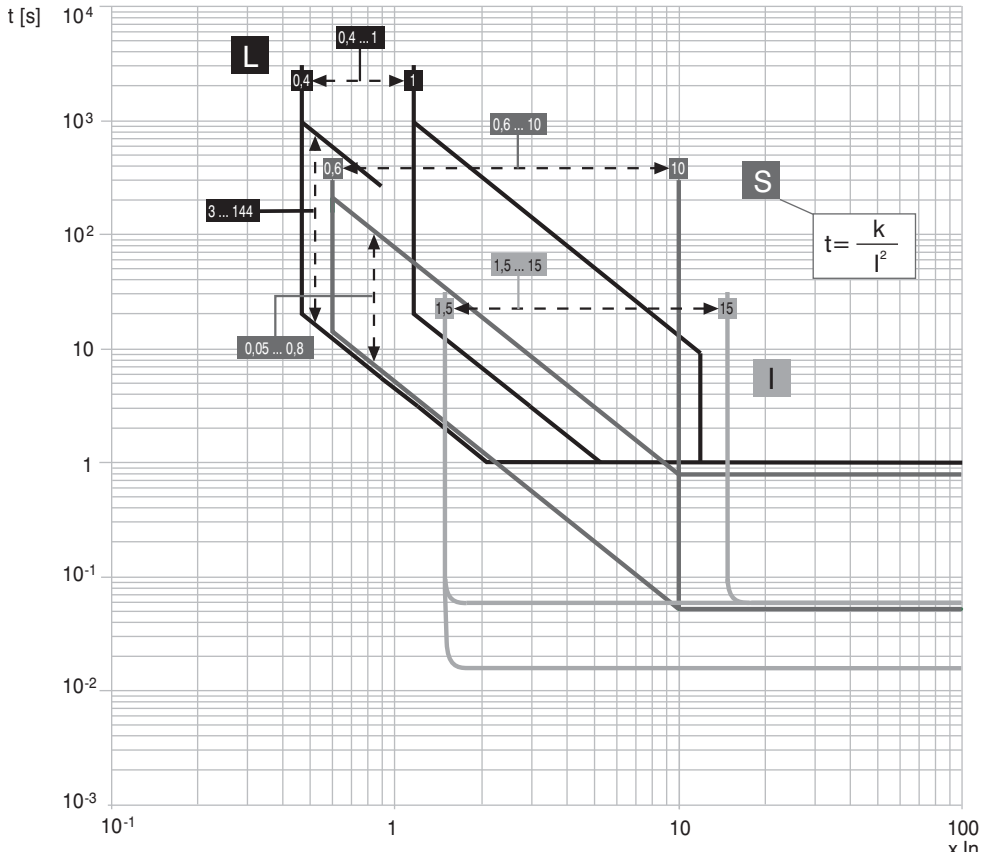
14.2.9.16. Table of measurements

Type of measurement	Range of values measured by the relay	Standard operation range	
		Range	Tollerance %
Phase and neutral currents	0,05 ... 16 In	0,3 ... 6 In	± 1,5
Internal ground fault current (internal source round return)	0,05 ... 4 In	0,3 ... 4 In	± 1,5
External ground fault current (external source round return)	0,05 ... 4 In	0,3 ... 4 In	± 1,5
Phase-to-phase and phase voltages (measured at the module's input and thus independent of the precision relating to the use of any VT)	10 V_{conc} ... 1,1x690 V_{conc}	50 V_{conc} ... 1,1x690 V_{conc}	± 1
Residual voltage (for systems with neutral only)	10 V_{conc} ... 1,1x690 V_{conc}	50 V_{conc} ... 1,1x690 V_{conc}	± 1
Peak factor	0,1 ... 6 In	0,3 ... 6 In	± 1,5
Total power factor	0,1 ... 1	0,5 ... 1	± 2,5
Mains frequency	35 ... 80 Hz	45 ... 66 Hz	± 0,2
Instantaneous active power on the single phase and total system	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Instantaneous reactive power on the single phase and total system	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Instantaneous apparent power on the single phase and total system	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Active energy	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Reactive energy	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5
Apparent energy	0,02 ... 16 Pn	0,3 ... 6 Pn	± 2,5

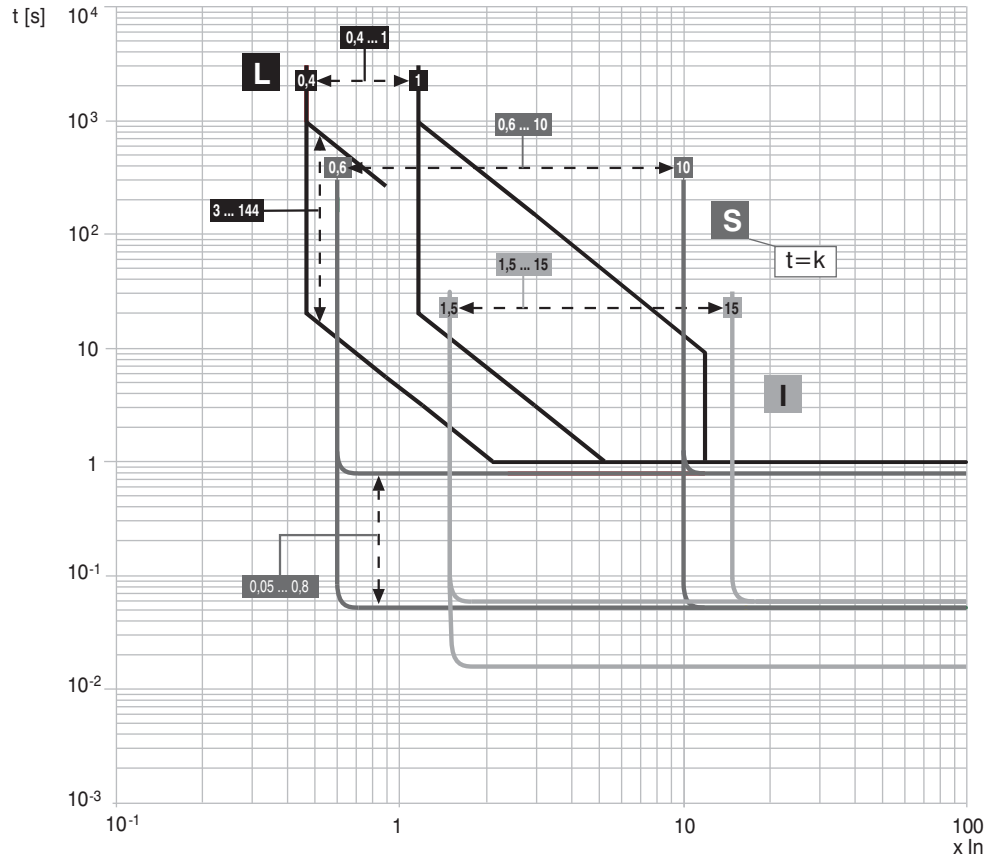
14.2.10. Trip curves

The trip curves given are for guidance and only show a sub-group of the possible selections (see par. 14.5.2).

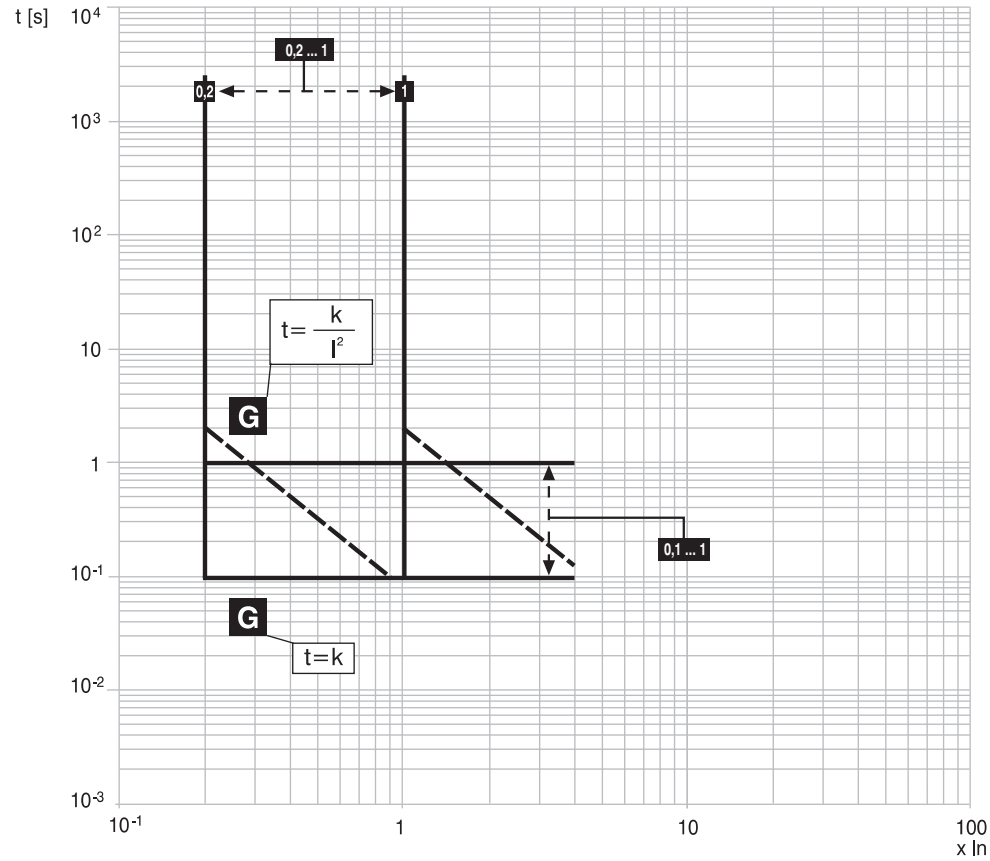
14.2.10.1. Trip curves for functions L-S L-S (t=k/I²)-I



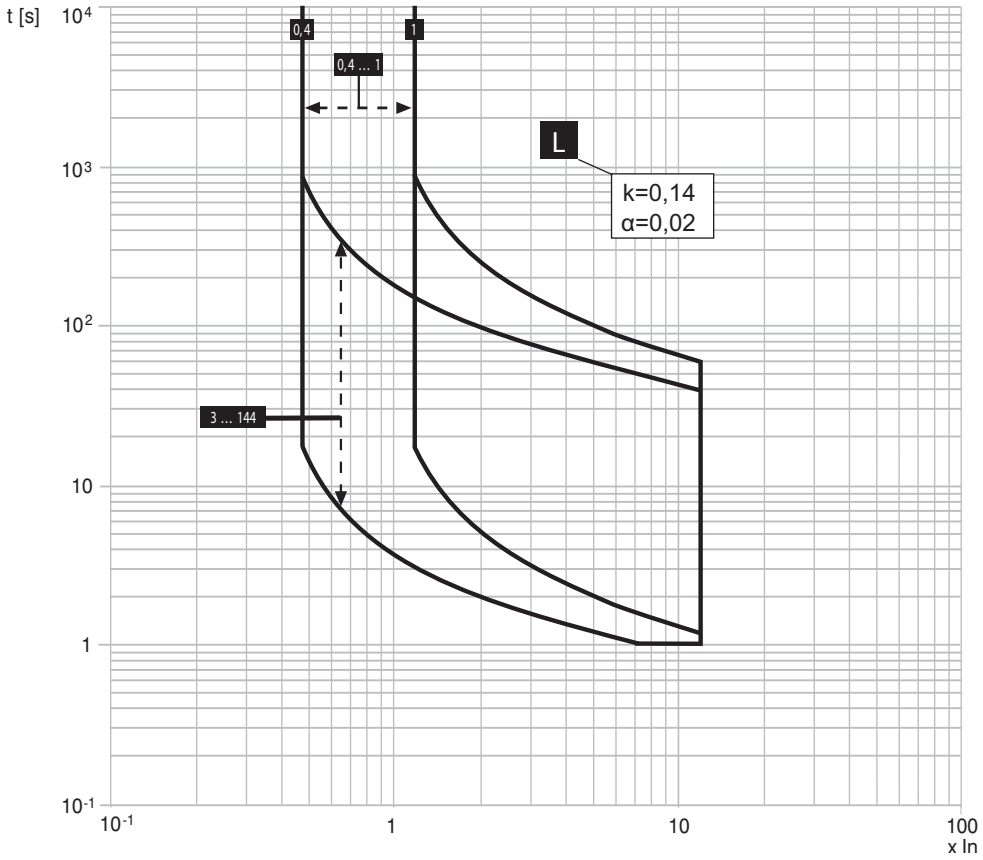
14.2.10.2. Trip curves for functions L-S(t=k)-I



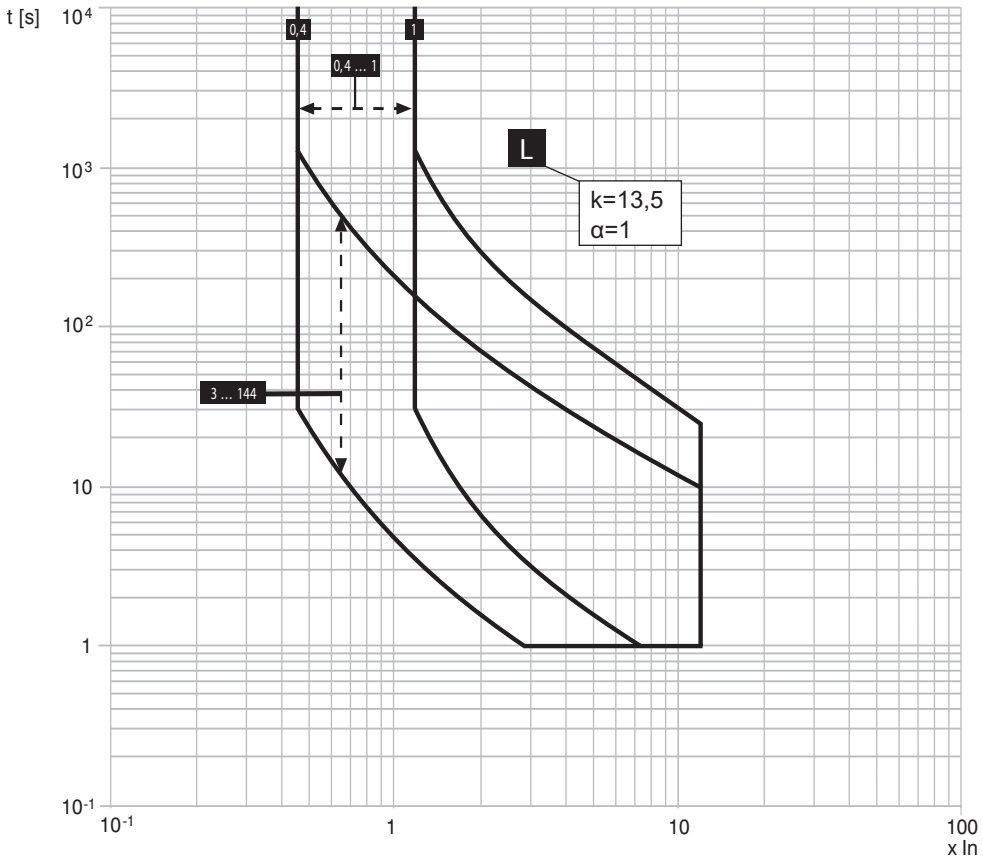
14.2.10.3. Trip curves for function G



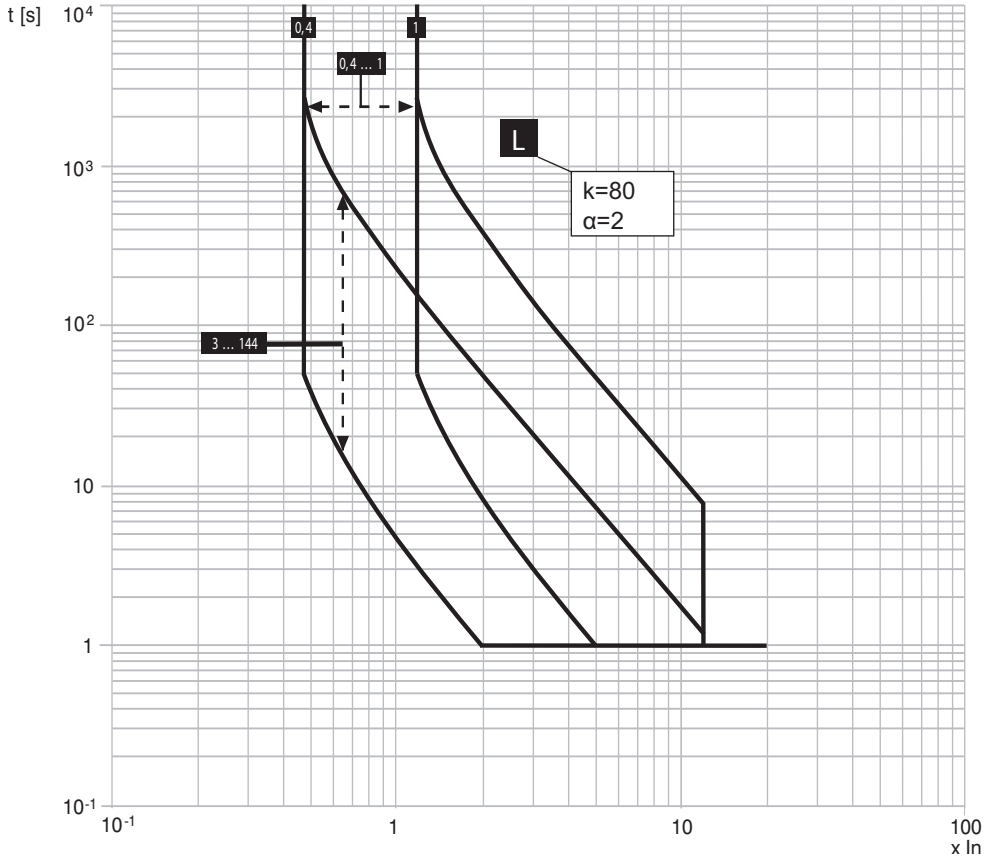
14.2.10.4. Trip curves for function L in accordance with IEC 60255-3 (type A)



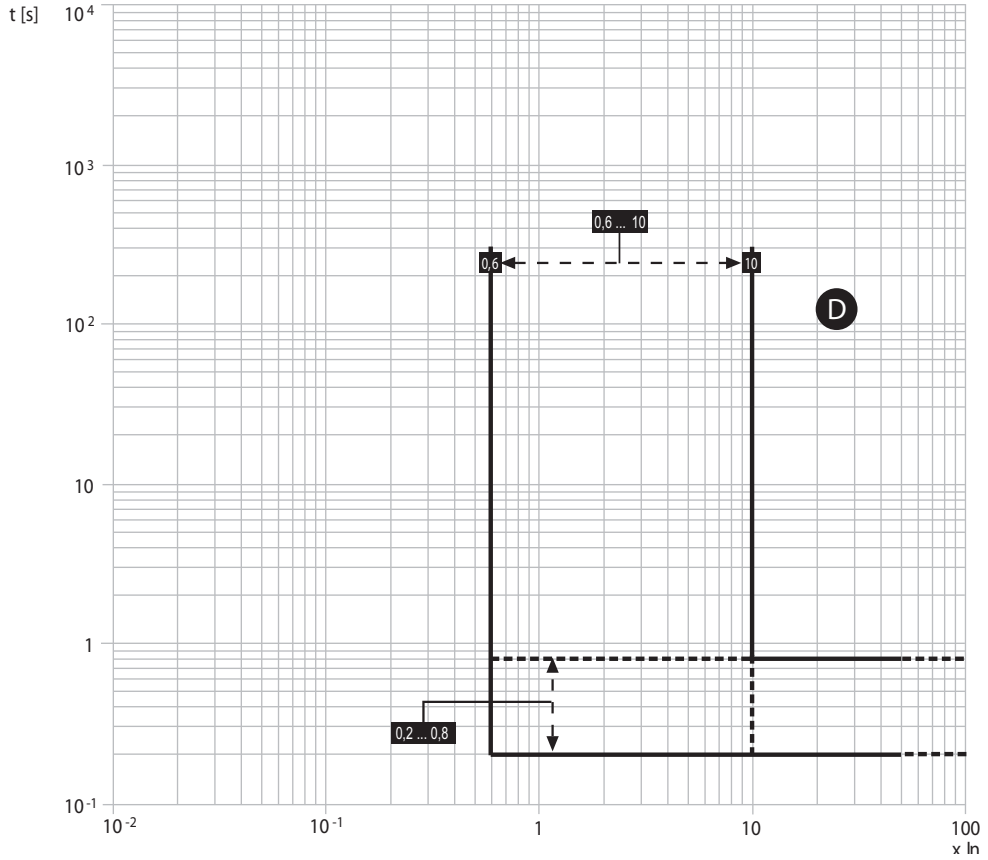
14.2.10.5. Trip curves for function L in accordance with IEC 60255-3 (type B)



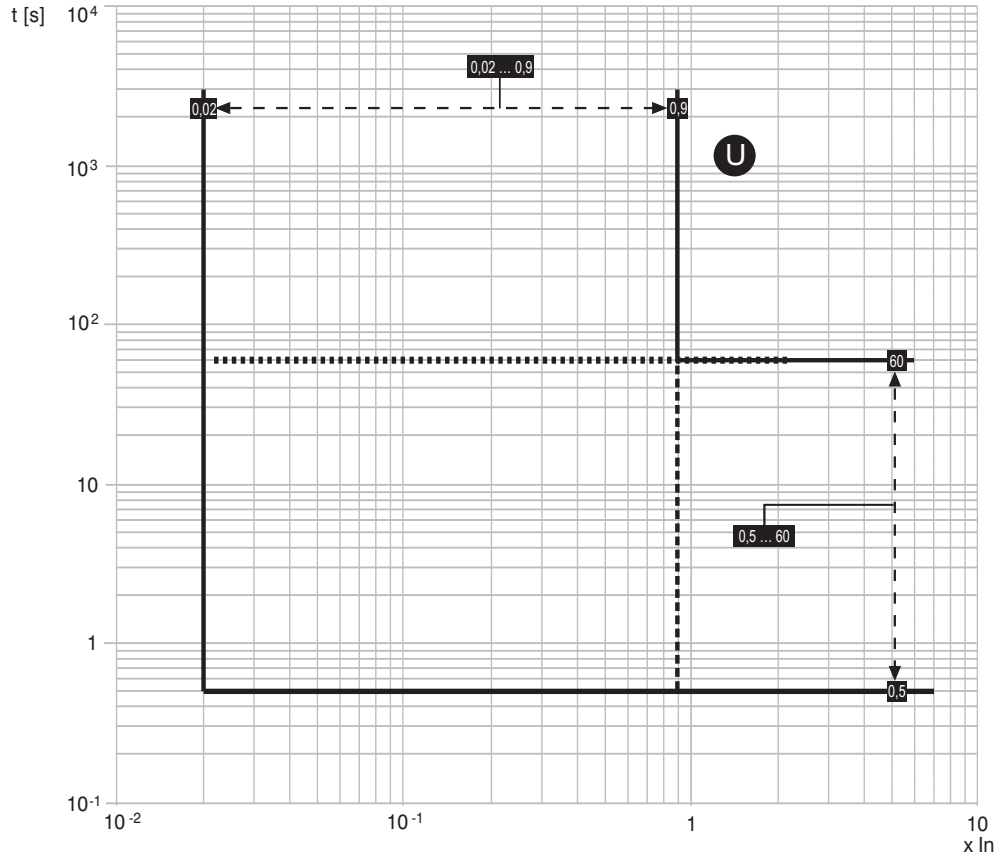
14.2.10.6. Trip curves for function L in accordance with IEC 60255-3 (type C)



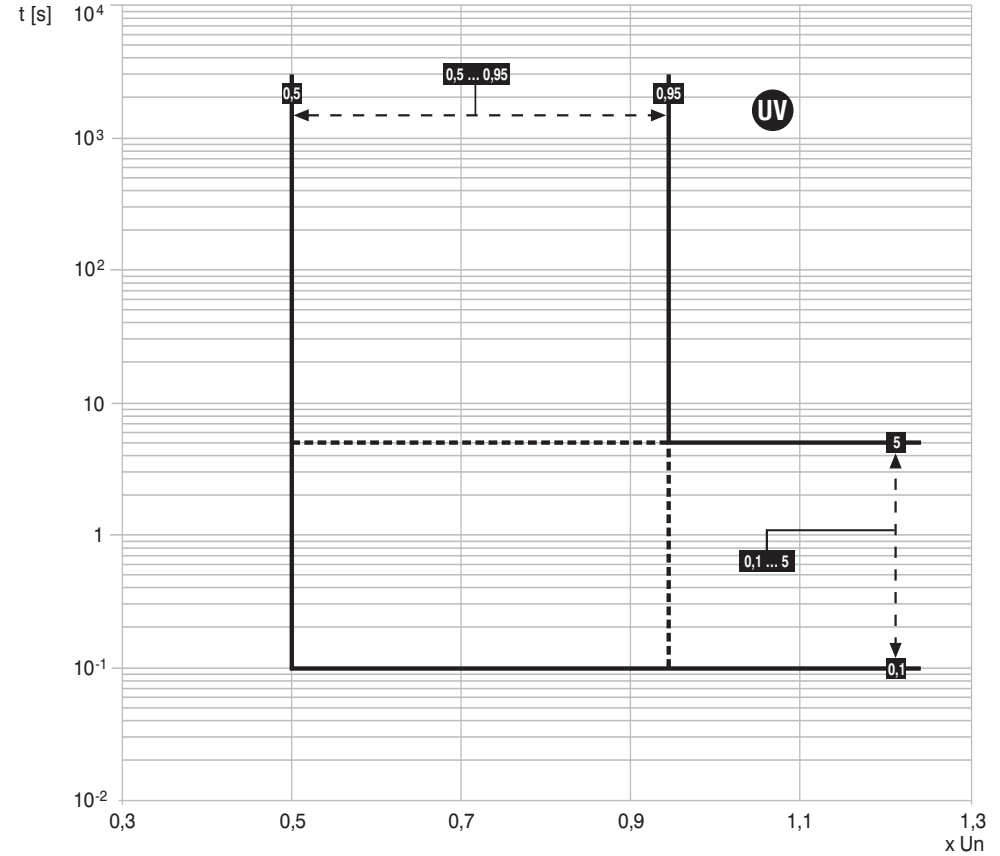
14.2.10.7. Trip curves for function D



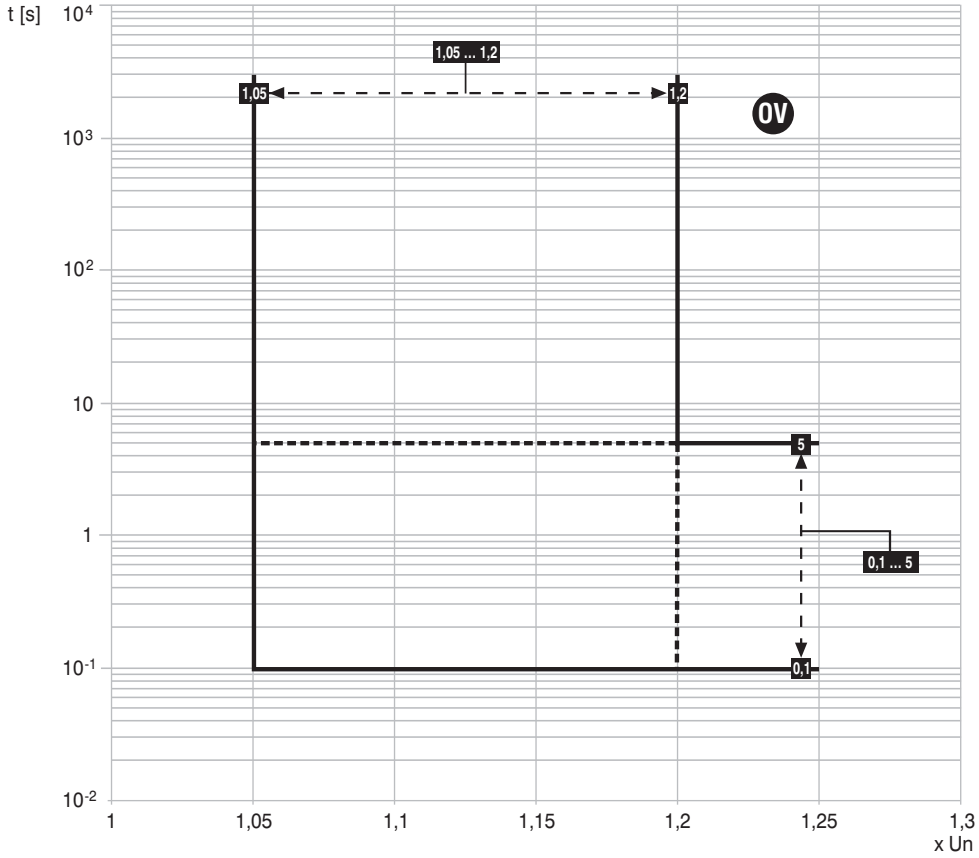
14.2.10.8. Trip curves for function U



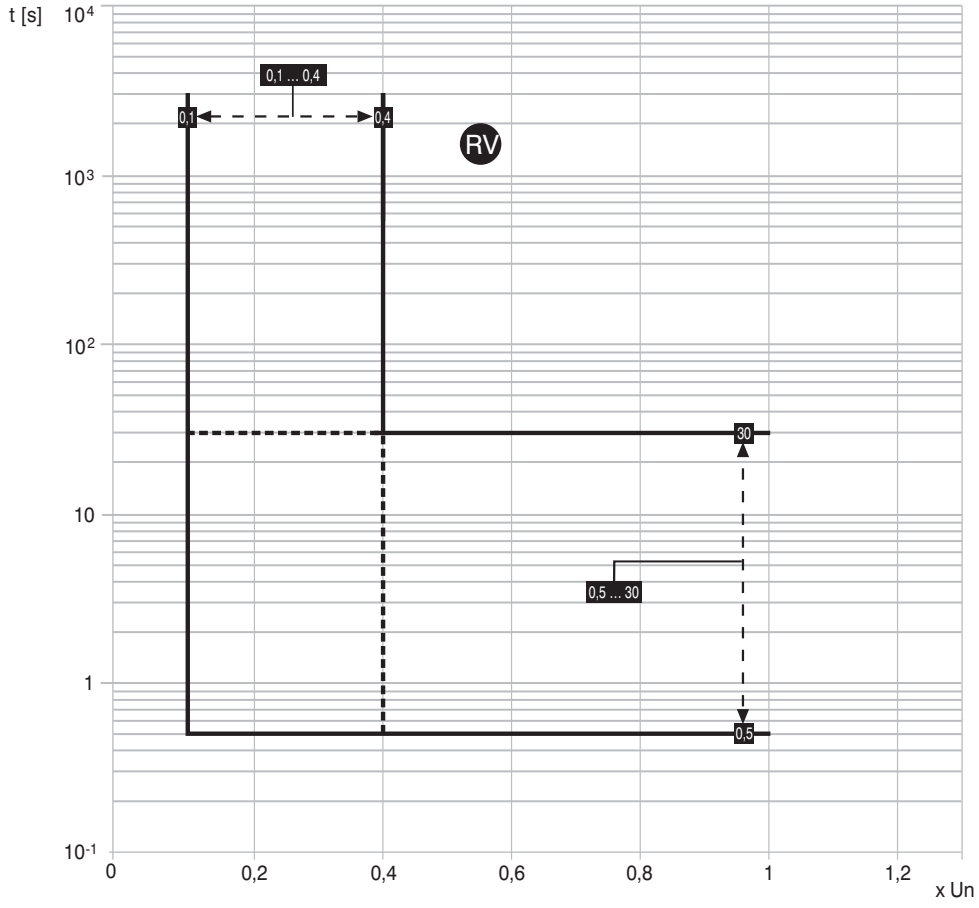
14.2.10.9. Trip curves for function UV



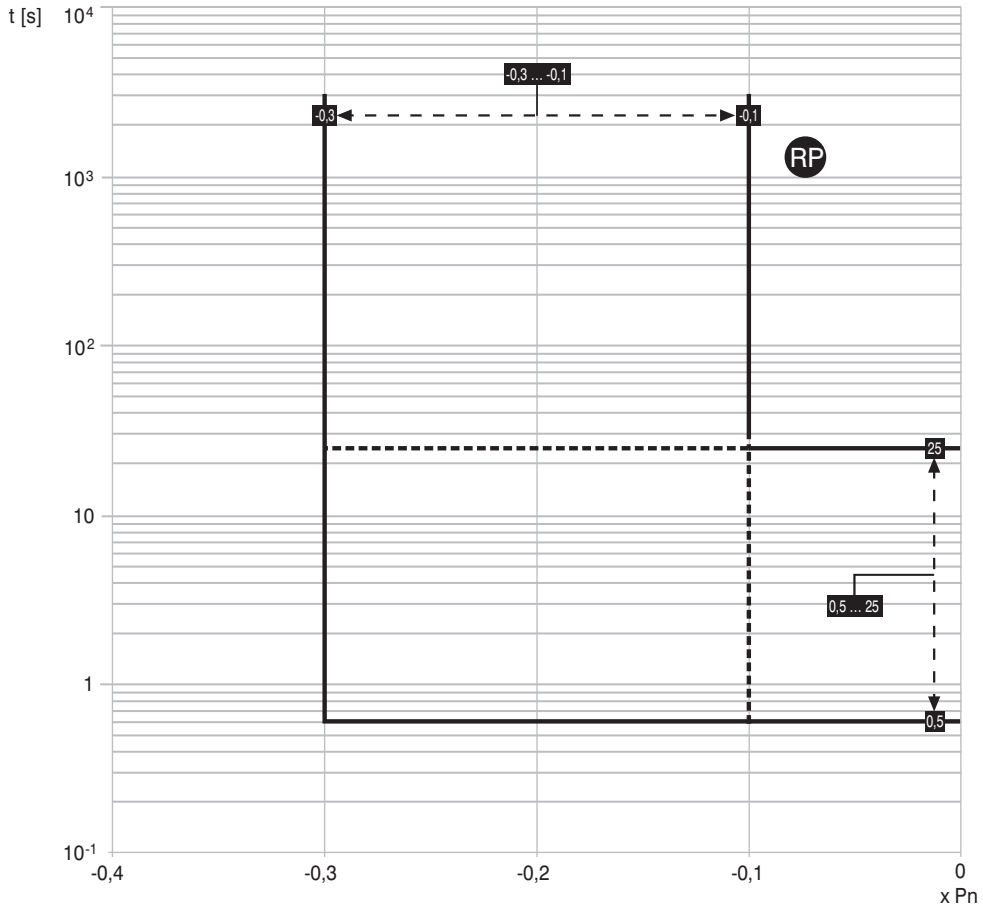
14.2.10.10. Trip curves for function OV



14.2.10.11. Trip curves for function RV



14.2.10.12. Trip curves for function RP



14.3. Putting into service

14.3.1. Connections

WARNING: For the connections provided by the user, it is recommended that you comply strictly with the recommendations contained in this document. This will enable us to satisfy all the international reference standards and guarantee perfect operation of the relay even under severe environmental and electromagnetic conditions. Pay particular attention to the types of cable, the connections to earth and the maximum distances.

WARNING: The maximum length of the VT - PR120/V wiring must not exceed 15 meters.
Use corded shielded two-wire cable (see note A to par. 11.2.2).
The shield must be connected to earth on both sides.

WARNING: Use VTs with a shield, connected to earth (see standard VT par. 14.3.2).
The VTs should only be used for voltages > 690V; for lower voltages the presence of the PR120/V module connected to the lower or higher busbars will be sufficient. With VT enabled, the Voltage Transformer In present data will be set and VT's phase-to-phase primary and secondary voltage properly adjusted.

14.3.1.1. Current sensor connection for external neutral

WARNING: If you want to connect the current sensor for the external neutral conductor to a three-pole circuit-breaker, remember to set I_nN. accordingly. During this procedure, the circuit-breaker must be open and preferably isolated

14.3.2. VT connections

WARNING: Dielectric strength tests are not allowed on the inputs and outputs of the releases or on the secondary lines of any connected VTs.

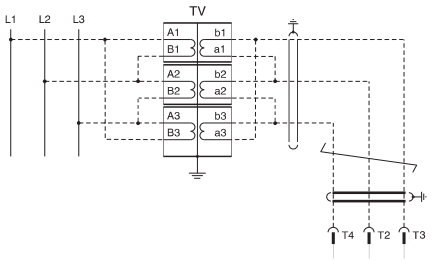
The following is a summary table of standard VT connections according to the type of plant.

VT Standard:
Single standard transformers, see par. 15.1.7.
The VTs must have a performance coming between the values of 10 and 20VA inclusive, 4 kV insulation between the primary and secondary.

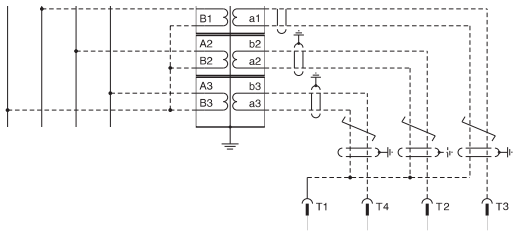
Installation system	"VT Standard" type transformer (Star/Star)	"VT Standard" type transformer (Delta/Delta)
	Application diagram	Application diagram
TN-C	B	A
TN-S	B	A
IT with neutral	B	A
IT	n.c	A
TT with neutral	A	B
TT without neutral	n.c	A

Note for B diagram:
- for TN-C systems the connection must be made to PEN
- for TN-S systems the connection must be made to N for configurations with neutral or PE for configurations without neutral; if the PE is used, the current thereon could be around a dozen mA. If a customer considers this value too high or has a residual current protection which risks being tripped, then application diagram A must be used.
- for IT and TT systems with neutral, the connection must be made to N

Application diagram A



Application diagram B

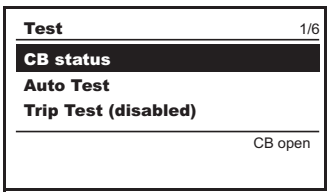


14.3.3. CS and TC connection test

WARNING: If the PR123/P was installed by the user, it is important, before closing the CB, to check the last line on the display when the relay is turned on for the first time via a PR030/B battery unit. No CS and/or TC disconnected messages must appear; if they do, do not close the circuit-breaker immediately and make the correct connectionsi.

14.3.4. Test

Before putting into service, a test can be conducted by means of the specific “Auto test” function which can be activated on the PR123/P. A positive result is shown on the display.
Then a test can be conducted on the whole TC chain, again using the specific function (Trip test). A positive result is shown by the circuit-breaker opening. To run a Trip Test, press the “i Test” button and the “Enter” button simultaneously.
Check the open or closed state of the circuit-breaker on the same “PR123/P Test” screen, checking that the CB is closed and de-energized.



14.3.5. Initial settings

If the PR123/P is supplied ready installed in the circuit-breaker, it is up to ABB SACE to set all the variables referring to the circuit-breaker or the specific application correctly (e.g. type of circuit-breaker, Rating Plug size...).
When the PR120/V module is installed, user must properly set the rated voltage.
Vice versa, if the PR123/P is supplied separately, it will be up to the user to set all the necessary parameters correctly.
Note that ABB SACE defines each possible setting according the content of the paragraph on the default parameters (see par. 14.4.4).

WARNING: Apart from this, it is absolutely indispensable for the user to modify the password and carefully define each modifiable parameter, before putting the PR123/P into service.

14.3.6. Password management

Specify a password? [0*]**

To enter “EDIT” mode it is necessary to enter a four-figure numerical password. The values attributable to the password go from 0000 to 9999. For the default password see par. 14.4.4.
Select the value of the first figure (between ‘0’ and ‘9’) by means of the ↑ and ↓ keys and press ↵ to confirm the figure and then move on to enter the next one. After entering the fourth figure, check the password you have entered. If the password is correct, you go from the “READ” state to the “EDIT” state.

If the password is wrong, the message

Wrong password

appears and remains until the **ESC** key is pressed (or until an interval of 5 seconds has elapsed).

It is also possible to interrupt the password entry procedure by pressing the **ESC** key.

Disabling the Password.
By setting the value of the password to [0000] (on the “Unit configuration” menu) the password prompt is disabled. It is therefore always possible to switch from “READ” to “EDIT”.

To enter a new password, select the “New Password” item on the “Settings/System” menu.

14.3.7. Replacing an electronic release

14.3.7.1. Installation

To complete the procedure for installing a PR123/P unit, follow the steps below:

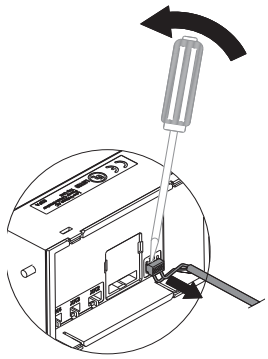
1. With the circuit-breaker open and preferably isolated, install the protection unit on the circuit-breaker
2. Power the unit ONLY from the PR030/B
3. If there are no other errors, the display will show the message Configuration (configuration error) accompanied by the yellow LED coming on permanently (warning)
4. Enter the unit’s “Settings” menu
5. Select “Circuit-breaker”
6. Select “Unit installation”
7. Input the password
8. Select “Install” and press “ENTER”
9. When the red led flashes on and off and the message Installation (installation error) is displayed, remove the PR030/B
10. Power the relay from any other source.

Check for the absence of configuration errors.

14.3.7.2. Uninstalling

To complete the procedure for uninstalling a PR123/P unit, follow the steps below:

1. With the circuit-breaker open and/or isolated power the unit from the PR030/B
2. Enter the unit’s “Settings” menu
3. Select “Circuit-breaker”
4. Select “Unit installation”
5. Input the password
6. Select “Uninstall” and press “ENTER”
7. Remove the PR030/B
8. Remove the PR123/P unit from the circuit-breaker
9. The remove the TC connector, proceed as indicated in the figure alongside.



It is not strictly necessary to complete the uninstalling procedure, but this enables the parameters relating to the circuit-breaker, such as contact wear and others, to be saved, otherwise these data would be lost. The data in question are then transmitted to the new PR123/P unit installed on the same circuit-breaker.

14.4. User interface

Rif.	Description
1	Voltage takeoff isolator
2	Busbar voltage LED
3	Pre-alarm indicator LED
4	Alarm indicator LED
5	Graphic display (the word ABB in the bottom left-hand corner indicates normal operation)
6	Serial number of the PR123/P
7	Rating plug
8	Pushbutton for exiting the sub-menus or for canceling (ESC))
9	Button for the cursor (UP)
10	Button for the cursor (DOWN)
11	ENTER key for confirming the data or changing the page
12	TEST connector for connecting or testing the release by means of an external device (PR030/B battery unit, BT030 USB wireless communication unit and PR010/T test unit)
13	“i Test” test and info button

The Graphic Display is of the LCD type with 128x64 pixels and it is backlit when there is an auxiliary voltage or a self-powering from a PR120/V module.
The display is always lit when there is a Vaux or, in self-powering mode with a minimum busbar current or powered from the PR120/V module as defined in par. 14.2.2.1
You can adjust the contrast on the display by means of the specific function available on the user interface settings menu (par. 14.5.4.1).

Description of icons displayed

Symbol	Description
	Remote control
	Dual setting active. Setting A set
	Fixed icon: data logger activated Flashing icon: triggering
	Vaux installed
	Parameter change stage

14.4.1. Use of pushbutton

The modifiable fields can be filled in using the ↑ or ↓ keys and confirming with the ↵ key. Once you have entered the page you need, you can move from one value to another by using the + or ↓ keys. To change a value, position the cursor over the value (the modifiable field will appear in reverse, i.e. white on a black background), and use the ↵ key.

To confirm the programming of the previously configured parameters, press the **ESC** key to scroll up through the menus until the programming confirmation page is displayed; select confirmation and press **ENTER** for data programming.

The “**i Test**” key must be used to perform the Trip test to view the information page and to see the last trip within 48 hours of the CB opening in self-powering mode.

14.4.2. Read and Edit modes

The menus map (see par. 14.5.1) shows all the pages which can be obtained and how to move between them from the keyboard, in the “READ” mode (just to read the data) or in the “EDIT” mode (to set the parameters).

Starting from any page displayed, the default page will be automatically displayed after about 120 sec inactivity (see par. 14.5.1).

The functions allowed depending on the state are:
“READ”:
- ✓ Consultation of the measurements and of the historical data
- ✓ Consultation of the unit configuration parameters
- ✓ Consultation of the protection parameters

“EDIT”:
- ✓ Everything allowed in READ mode
- ✓ Configuration of the unit
- ✓ Programming of the parameters relative to the protections
- ✓ TEST functions of the unit

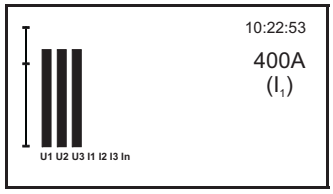
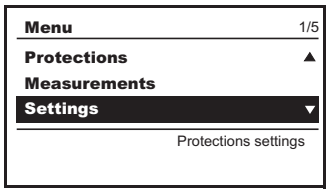
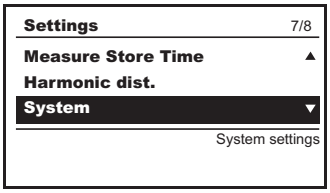
To access the “EDIT” mode, it is necessary to press the ↵ key on a page with fields which can be edited. A password will then be required to enable you to switch to the editing mode.
The use of the keys is summarized in the following table:

Key	Function
	Move between pages Move within menu Change parameter values
	End setting phase and confirm result Choose menu item
	Access to surfing menus from the default pages Return to previous level when surfing within the menus, until you return to the default pages Exit the parameter changing phase, aborting the change
	This key is used to re-enable the display after it has gone off within 48 hours of the opening of the circuit-breaker in self-powering mode

14.4.3. Changing parameters

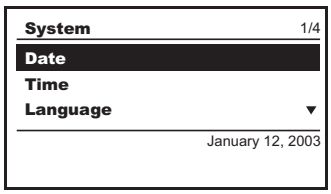
Moving within the Main Menu you can reach all the pages relating to the configurations and parameter settings with the opportunity to change the values specified for the parameters.
After any programming, you need to Confirm/Cancel/Change any changes you have made. This procedure is not applicable to all the programming activities. Two examples are provided below: one concerns the case in which no confirmation is needed for the changes you have made, while in the other a confirmation window appears.

Procedure not requiring the confirmation of any programming
For instance, to set the System Date, the correct sequence is as follows:

Press ESC to access the Main Menu	
From the Main Menu, select SETTINGS press the ↵ key (enter)	
Select SYSTEM press the ↵ key (enter)	

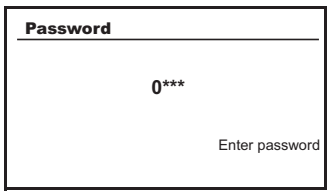
Select the menu item DATE to change

press the ↵ key (enter)



You will be prompted to input a Password
complete the password entry procedure (par. 14.3.6)

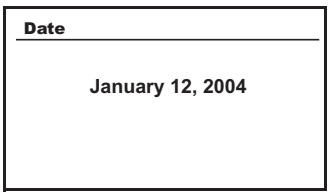
press the ↵ key (enter)



Change the date using the keys ↓ (arrow down)

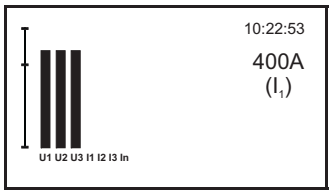
↑ (arrow up) and confirm by pressing the ↵ key (enter).

Press ESC twice to return to the Main Menu.



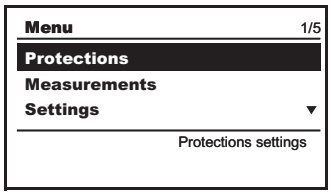
Procedure requiring the confirmation of any programming
For instance, to change the Curve of the Protection L, the correct sequence is as follow

Press ESC to access the Main Menu



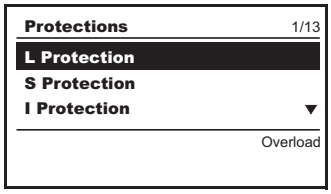
From the Main Menu select the item PROTECTIONS

press the ↵ key (enter)



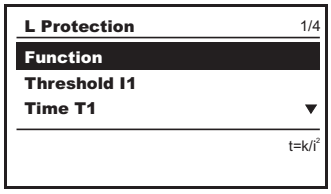
From the Protections Menu select the item PROTECTION L

press the ↵ key (enter)



From the Protection L Menu select the item CURVE

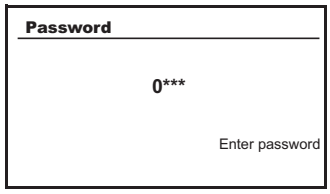
press the ↵ key (enter)



You will be prompted to input a Password

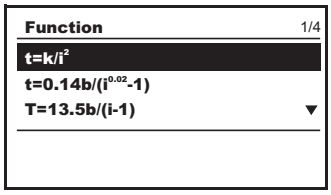
complete the password entry procedure (par. 14.3.6

press the ↵ key (enter)



Select the value you want from the list
and confirm pressing the ↵ key (enter).

Press ESC twice

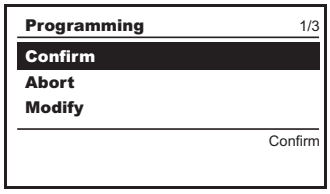


Before accessing the Main Menu, the following box will appear:

Accept the new configuration

Reject the new configuration (the previous configuration is retained)

Change the previously input values.



To select the required option use the ↓ (arrow down), ↑ (arrow up) keys, and press ↵ (enter) to confirm.

14.4.3.1. Modification of basic configuration

No parameter settings can be made if the PR123/P unit is in alarm conditions.

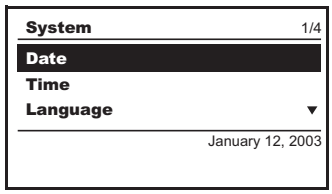
The configuration of the unit must be done in EDIT mode.

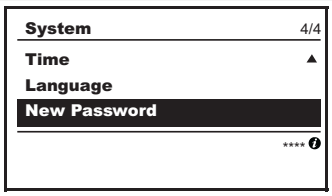
Following the instructions given in par. 14.4.3, view the following on the display:

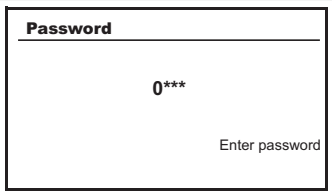
Change system date

Change system time

Select system language







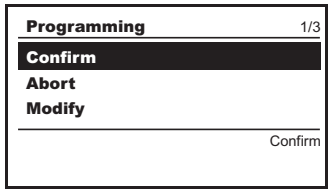
To change the system password, select the relevant menu item and press ↵ (enter); then you will be prompted to enter the OLD password, and afterwards you can input the new one twice.
Press ESC twice to return to the Main Menu

Before accessing the Main Menu, the following box will appear:

Accept the new configuration

Reject the new configuration (the previous configuration is retained)

Change the previously input value.



Note: To set the system language, check that:
- the relay is set to local (when PR120/D-M is installed);
- the CB is open;
- the auxiliary power supply is installed (Vaux 24VDC and/or busbar voltage through PR120/V and/or PR030/B).
When anyone of these conditions is not complied with, the relay does not allow the language to be changed.

14.4.4. Default settings

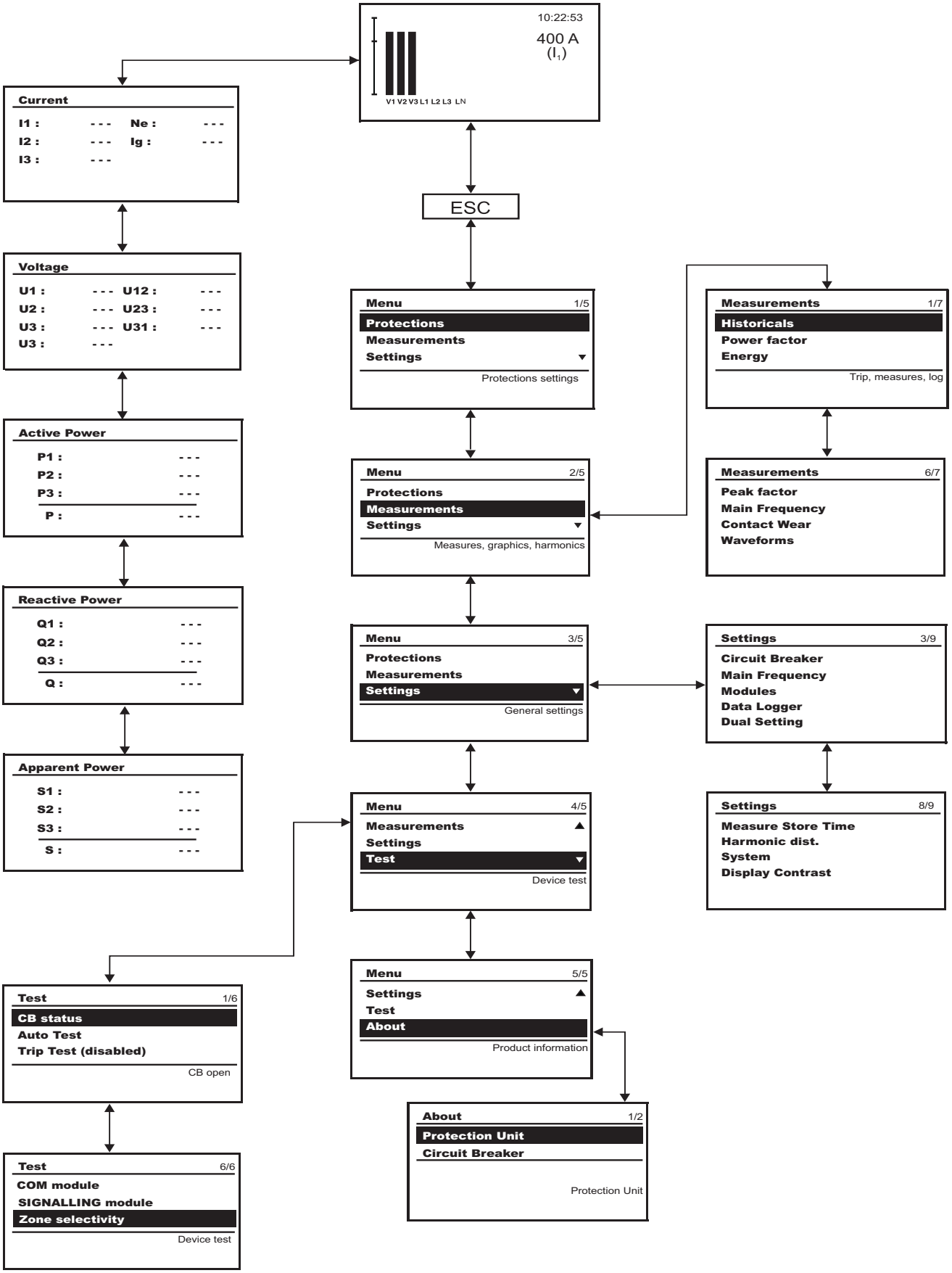
The PR123/P is supplied by ABB SACE with the following predefined parameters (Set A and Set B):

#	Protection	On/Off	Thresholds	Time	Curve	T.M.	ZS	Trip
1	**L**	--	1 In	144 s	I^2t	Off	--	--
2	**S**	Off	6 In	50 ms	K	--	Off: 0,04 s	--
3	**D**	Off	6 In	0,2 s - 0,2 s			Off: 0,13 s	--
4	**I**	On	4 In	--	--	--	--	--
5	**G**	Off	0,2 In	0,4 s	K	--	Off: 0,04 s	On
6	**U**	Off	50 %	5 s				Off
7	**OT**	--						Off
8	**K LC1**	Off	50 % I1					
9	**K LC2**	Off	75 % I1					
10	**UV**	Off	0.9 Un	5 s				Off
11	**OV**	Off	1,05 Un	5 s				Off
12	**RV**	Off	0,15 Un	15 s				Off
13	**RP**	Off	- 0,1 Pn	10 s				Off
14	**UF**	Off	0,9 Fn	3 s				Off
15	**OF**	Off	1,1 Fn	3 s				Off
16	**Language**	--	Engl					
17	**Net Frequency**	--	50 Hz					
18	**PR021/K**	Off						
19	**Neutral sel.**	--	*					
20	**Toroid Selec.**	--	None					
21	**Ext. ground tor.**	Off	100 A					
22	**Rated Voltage**	--	380V					
23	**S startup**	Off	6 In	100 ms				
24	**I startup**	Off	4 In	100 ms				
25	**G startup**	Off	1 In	100 ms				
26	**Password**	--	0001					
27	**Measuring interval**	--	60 min					
28	**Iw**	Off	3 In					
29	**Harmonic distortion warning**	Off						
30	**Power direction**	--	top → bottom					
31	**MCR**	Off	6 In	40 ms	--	--	--	--
32	**Start up activation threshold**	--	0,1In					

Note:
* = OFF for three-pole versions
* = 50% for four-pole versions
* = 100% for full size versions

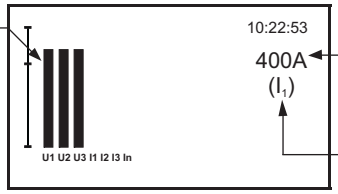
14.5.1. Menu

As seen previously, the PR123/P uses the display to show messages, diagrams and menus. These are organized in a logical and intuitive way. The following is a general layout showing how to access the main menu pages.



Each time the unit is turned on, or after more than 2 minutes of inactivity on the keyboard, the display indicates the following page (default):

Percentage of the actual currents and voltages with respect to the rated values (100%)

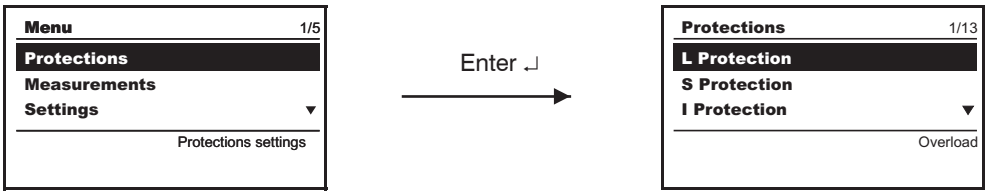


Current of the phase under the greatest load

Indication for the phase under the greatest load (L1, L2, L3, N)

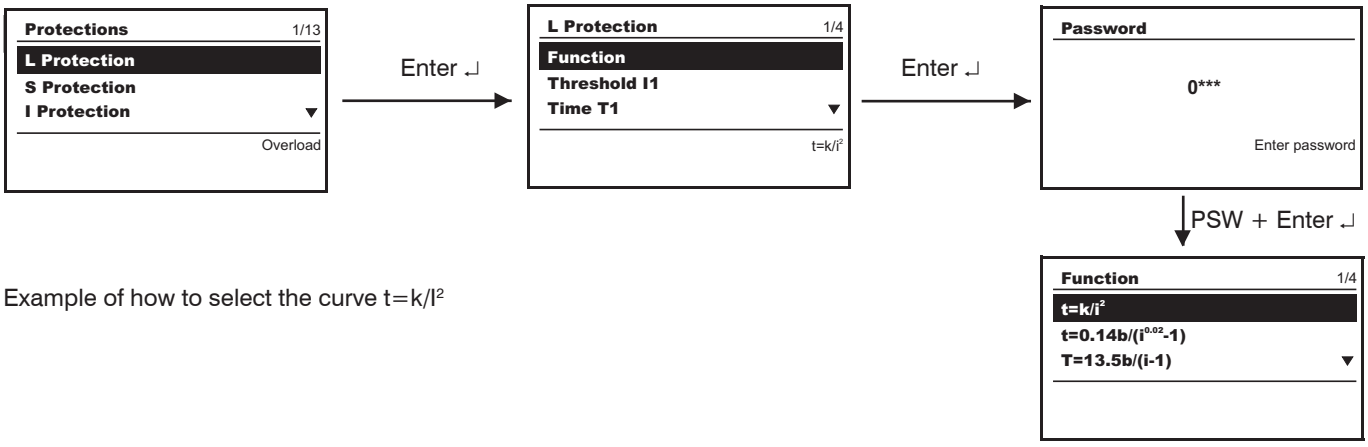
14.5.2. Protections Menu

From the interface you can press ENTER to access the menu of the various protections available on the display.



Using the “arrow UP” and “arrow DOWN” you can view the various protections.
On the whole, the data that you can display concern the protections:
L, S, S2, D, I, G, Gext, RC, U, UV, OV, RV, RP, UF, OF, OT, LOAD PROTECTION.

Example of surfing the Protections menu
From the Protection main page you can press ENTER to go to the Protection L Menu.
You can use “arrow UP” and “arrow DOWN” to select the items on the menu and confirm by pressing ENTER. Pressing this key triggers a Password prompt, then you can select the functions associated with the protection L (as in the example).



Example of how to select the curve $t=k/I^2$

Similarly, to access the menus for the other protections, see the Protections Menu table below.

14.5.2.1. Protections Menu table

Protection	Parameter / Function	
L	Curve	
	Threshold I1	
	Time t1	
	Thermal memory	ON / OFF
S	Enable	ON / OFF
	Curve	
	Threshold I2	
	Time t2	
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	

Protection	Parameter / Function	
S2	Enable	ON / OFF
	Threshold I2	
	Time t2	
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
D	Enable	ON / OFF
	Threshold I7	
	Time t7 Fw	
	Time t7 Bw	
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
I	Enable	ON / OFF
	Threshold I3	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
G	Enable	ON / OFF
	Curve	
	Threshold I4	
	Time t4	
	Enable Trip	ON / OFF
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
Gext	Enable	ON / OFF
	Curve	
	Threshold I4	
	Time t4	
	Enable Trip	ON / OFF
	Zone selectivity	ON / OFF
	Selectivity time	
	Enable StartUp	ON / OFF
	StartUp threshold	
	StartUp time	
RC	Threshold I4	
	Time t4	
U	Enable	ON / OFF
	Function	Currents/Voltages
	Threshold I6	
	Time t6	
	Enable Trip	ON / OFF
UV	Enable	ON / OFF
	Threshold U8	
	Time t8	
	Enable Trip	ON / OFF
OV	Enable	ON / OFF
	Threshold U9	
	Time t9	
	Enable Trip	ON / OFF

Protection	Parameter / Function	
RV	Enable	ON / OFF
	Threshold U10	
	Time t10	
	Enable Trip	ON / OFF
RP	Enable	ON / OFF
	Threshold P11	
	Time t11	
	Enable Trip	ON / OFF
UF	Enable	ON / OFF
	Threshold f12	
	Time t12	
	Enable Trip	ON / OFF
OF	Enable	ON / OFF
	Threshold f13	
	Time t13	
	Enable Trip	ON / OFF
OT	Enable Trip	ON / OFF
Load Control	Threshold 1	
	Enable	ON / OFF
	Threshold	
	Threshold 2	
	Enable	ON / OFF
	Threshold	
	Threshold Iw	
	Enable	ON / OFF
	Threshold	

Note: for an explanation of the characteristics of the single protections and their settings and corresponding curves, see par. 14.2.9.

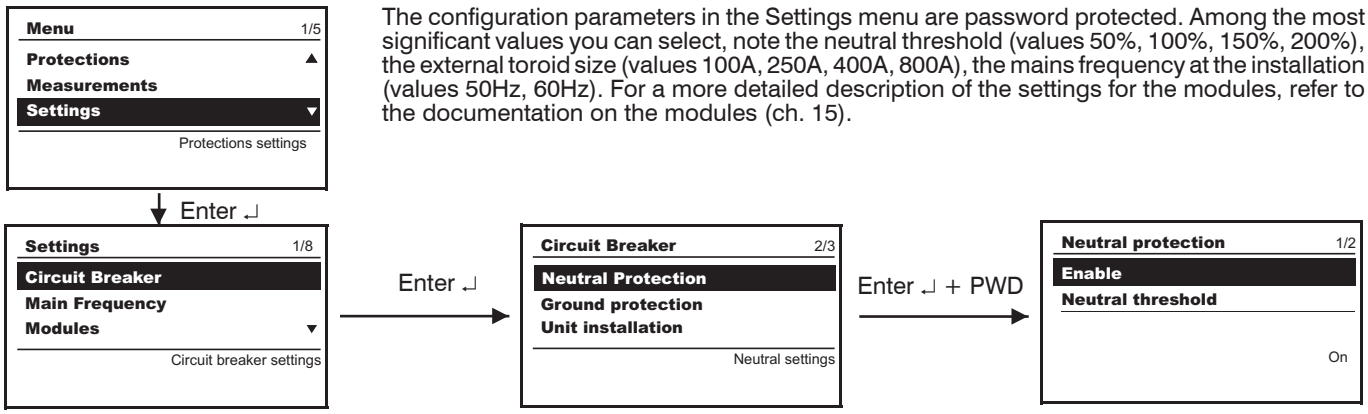
14.5.3. Measurements Menu

For a complete description of the functions of the PR120/V module, see par. 15.1.
The following is a summary of the parameters accessible from the menu in the PR123/P unit

14.5.3.1. Measurements Menu table

Protection	Parameter / Function	Values	Notes
Historicals	Trips		Last trip (20)
	Events		Events log (80 events max.)
	Measurements		
	I Max		Maximum active current
	P Max		Maximum active power
	P Mean		Mean active power
	U Max		Maximum voltage
	U Min		Minimum voltage
	Reset measurements		
Power factor			Cosφ misurato
Energy	Energy meters		
	Reset meters		
Peak factor			
Mains frequency		50 Hz 60 Hz	Measured value
Contact wear			Percentage of wear on CB contacts
Waveforms	I1, I2, I3		Graph, harmonics
	N		Graph, harmonics
	Voltage 12, 23, 31		Graph, harmonics

14.5.4. Settings Menu



The configuration parameters in the Settings menu are password protected. Among the most significant values you can select, note the neutral threshold (values 50%, 100%, 150%, 200%), the external toroid size (values 100A, 250A, 400A, 800A), the mains frequency at the installation (values 50Hz, 60Hz). For a more detailed description of the settings for the modules, refer to the documentation on the modules (ch. 15).

14.5.4.1. Settings Menu table

	Parameter / Function	Values	Notes
Circuit breaker (*)	Neutral protection		
	Enable	ON/OFF	
	Neutral threshold	50%-100%-150%-200%	
	Ground protection		Said protection is provided only in the event of an external toroid being used
	External toroidal transformer		
	Toroid size SGR	Absent, SGR, Rc	
Mains frequency		50 Hz - 60 Hz	
Modules	Module		
	PR120/V - Measuring	if any	see par. 14.5.4.4.1
	PR120/D-M - COM	if any	see par. 14.5.4.4.2
	PR120/K - Signalling	if any	see par. 14.5.4.4.3
	Unità Bus Locale	Absent - Present	
Data logger	Enable	ON/OFF	See Annex par. 16.3
		Sampling frequency	
		Stop event	
		Stopping delay	
		Restart	
		Stop	
Dual setting	Enable	ON/OFF	
	Default setting	SET A / SET B	
	Dual Set CB closure		
	Dual Set with Vaux		
Measurement interval		from 5 to 120 min, step 5 min	
Harmonic distortion		ON/OFF	The warning indicates that the distortion exceeds factor 2.1
Sistem	Date		
	Time		
	Language	English/Italiano/Francais/ Deutsch/Español	
	New password		
Display	Contrast		

* With the three-pole circuit breaker, the “3P+N” option is displayed and must be enabled if the outside neutral is installed.

The summary table relates to the surfing of the pages dedicated to the PR120/K module (see par. 15.3) and to the PR021/K unit (see par. 16.1).

14.5.4.2. Neutral adjustment

The neutral protection is normally set to a current value 50% of the adjustment made on the phases.
In some installations, where particularly high harmonics occur, the current circulating on the neutral may be higher than that of the phases.
In the SACE PR123/P release, this protection can be set for the following values: I_nN = 50% - 100% - 150% - 200% * I_n.

14.5.4.2.1 Neutral adjustment specifications

To adjust neutral (InN) comply with the following formula: $I_1 \times I_nN \leq Iu$.
With a 4-pole CB, this setting is checked by the relay which signals any failure by means of a LED (see par. 14.6.1) and adjusts this parameter independently to the accepted limits.
With a 3-pole CB, with external neutral, the relay performs no checks and setting is to be done by user.

E.g. With E1B800 CB having a 400A Rating Plug, Iu = 800A and I1 = 1In, InN adjustment may be: 50-100-200%.
With E1B800 CB having a 800A Rating Plug, Iu = 800A and I1 = 1In, InN adjustment may be: 50-100%.

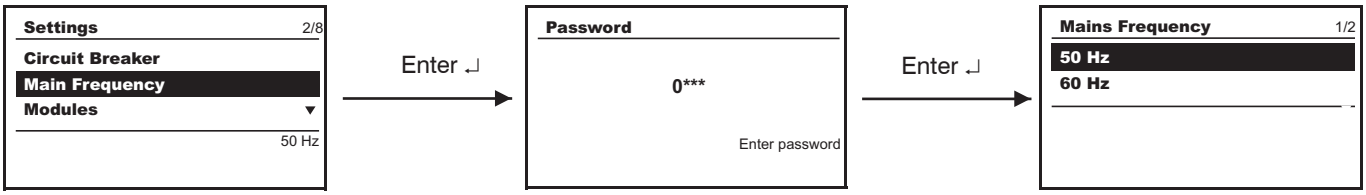
Note 1: The adjustment $I_1 = 1I_n$ is meant as the maximum adjustment of the overload protection. The actual maximum allowable adjustment must take into account any temperature derating, the terminals used and the altitude, or In (rating plug) ≤ 50% of CB size.

WARNING: Failure to comply with the setting limits for "I_n" and "I_nN" can cause circuit-breaker damage with consequent risks even for the operator.

In any case, the relay records any setting error between I_1 and the Neutral setting and it signals this by means of the warning (see par. 14.6.3). For four-pole CBs only.

14.5.4.3. Mains frequency settings

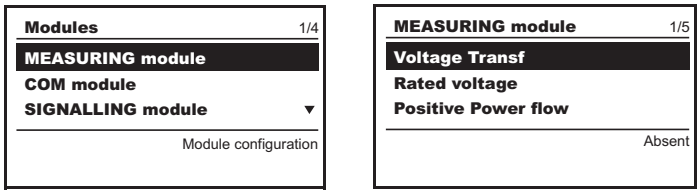
In the Mains frequency menu, you can choose between the frequency values: 50, 60Hz.



14.5.4.4. Modules

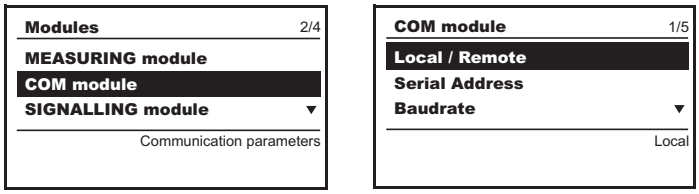
When you access the Settings menu, there is a set of menus available relating to the modules.

14.5.4.4.1 PR120/V - MEASURING module



In the measuring module you must enter a password and can then opt for the absence or presence of the voltage transformer. Moreover, you can select the values of the primary voltage (100, 115, 120, ... 1150V) and secondary voltage (100, 110,..,230V). The power flow can be Bottom → Top or Top → Bottom. After entering a password you can choose whether the neutral connection is to be Absent or Present. For three-pole CBs only.

14.5.4.4.2 PR120/D-M - COM module



The local or remote modes can be selected after entering a password. The serial address can be displayed after entering a password. The Baud Rate can be set on the values 9600 and 19200 bit/s. The physical protocol provides for the options: (8,E,1), (8,0,1), (8,N,2), (8,N,1). The addressing can be selected as standard Modbus or ABB. For further information on the PR120/D-M communication MODULE, see paragraph 15.2 in this manual.

14.5.4.4.3 PR120/K - SIGNALLING module

For a thorough examination of the signalling module, refer to the corresponding section of the module, paragraph 15.3.

14.5.4.4.4 PR120/D - BT module

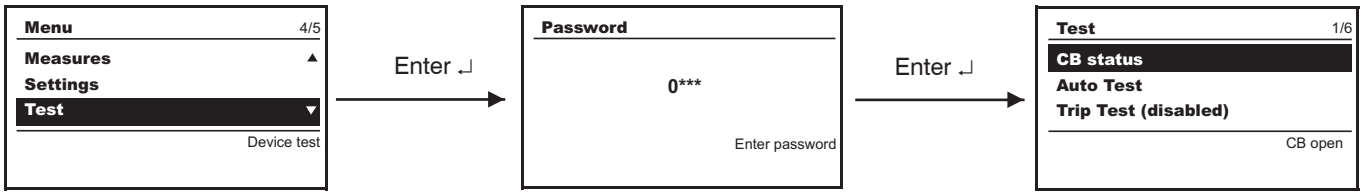
This module is for wireless communication based on the Bluetooth standard between the PR123/P protection release and a laptop with a Bluetooth port. For further information, see the description of the module in paragraph 15.4.

14.5.4.4.5 Settings for the Local Bus unit

If the PR021/K unit is connected, you need to enable the local bus by selecting present.

14.5.5. Test Menu

Access to the Test menu is password protected.



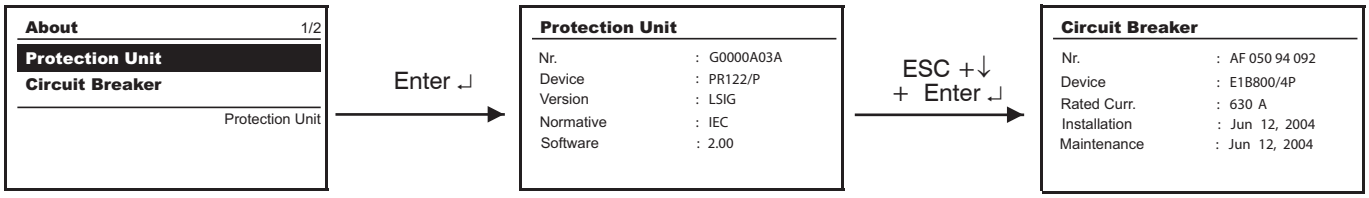
The menu shows the state of the CB, in the dialog module (COM module) the state of the springs and the position of the CB, and in this submenu you can make the CB open or close.
Using the “Trip Test” function lets you view the disabling/enabling of the Trip. If it is enabled, the circuit-breaker is opened. The function is only available with a busbar current of nil (use Vaux, PR030/B or PR010/T).
On the page only with Vaux, you can also see the state of the circuit-breaker “STATUS”, and thus make sure that the input is correctly wired.
The surfing path is summarized in the following table:

14.5.5.1. Test Menu table

	Parameter / Function	Values	Notes
CB status		Open/Closed/Indefinite	Indefinite in case of fault only
Auto Test		Display test	
Trip Test		Enabled/Disabled	
PR120/D-M module	State of springs	Loaded/Unloaded	
	Position of CB	Isolated/Withdrawn	
	Open CB		
	Close CB		
PR120/K module	Input	ON	
	Auto Test	- - -	
Zone selectivity	Protection S/ DFW		
	(status) Input	ON/OFF	
	Force Output		
	Release Output		
	Protection G/ DBW		
	(status) Input	ON/OFF	
	Force Output		
	Release Output		

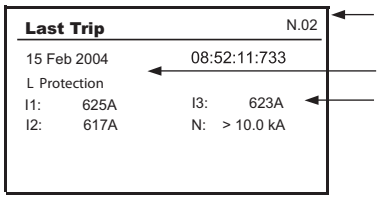
14.5.6. Information Menu

The Information Menu enables you to view the data relating to the protection unit and the type of circuit-breaker.



14.5.6.1. Information on the trip and opening data

The PR123/P unit saves all the information relating to the type of protection tripped, the opening data, the date and time. Using the “i Test” key makes the release show all these data directly on the display. There is no need for an auxiliary power supply for this function. With an auxiliary power supply, the information is shown immediately on the display without the need to press the “i Test” key and remains displayed indefinitely until you press the key.
The information remains available for 48 hours with dead relay. The data relating to the last 20 trips are stored in the unit’s memory. By connecting a PR030/B battery unit and PR010/T or a BT030 USB wireless communication unit, you can retrieve the information relating to the last 20 trips recorded.
Access to view the opening data is via the Historicals submenu in the Measurements menu. The following is an example of the information provided:



← Number of openings due to the protections and to the TRIP tests.
← Indication for protection tripped.
← Value of the currents interrupted on phases (L1, L2, L3), neutral (Ne) and Ground (if G has been trip

Again in the Measurements menu, you can view the percentage of contact wear, which is an indication of the electrical life of the electrical contacts in the circuit-breaker.

In any case, functionality of the relay is in no way modified by the presence of the wear messages.
The prealarm message (wear > 80%, “warning” LED lighting up) indicates that the wear has reached a high value. The alarm message (100% wear, “alarm” LED lighting up) indicates that it is necessary to check the state of contact wear.
The percentage of wear depends on the number of openings carried out by the circuit-breaker and by the absolute current interrupted during each of them.

14.6. Definition of alarms and signals in the PR123/P unit

14.6.1. Optical signals

Signalling	Description
Led **Warning** (yellow)	• The prealarm threshold has been exceeded; one or more phases with current values in the range $0.9xI_1 < I < 1.05xI_1$ (on the Ne it depends on the selection made; for instance, at 50% the values are halved); • Presence, between two or three phases, of unbalance above the value programmed for the “U” protection, with protection trip disabled; • Presence of distorted wave form with form factor> 2.1; • Contact wear greater than 80% (and less than 100%); • WARNING Threshold I_w exceeded; • Circuit-breaker state error; • Frequency out of range; • Configuration error; • Settings inconsistency.
Led **Warning** (yellow 0,5Hz)	• WARNING threshold of relay’s internal temperature exceeded.
Led **Warning** (yellow 2Hz)	• ALARM threshold of relay’s internal temperature exceeded.
Led **Alarm** (red)	• Presence of overload on one or more phases with current values I >1.3 I1 (timing protection “L”) (on the Ne it depends on the selection made; for instance, at 200% the values are doubled)*; • Timing in progress for protection function S; • Timing in progress for protection function I; • Timing in progress for protection function G; • Timing in progress for protection function D; • Timing in progress for the voltage (UV, OV, RV), frequency (OF, UF) protection functions; • Timing in progress for the reverse active power protection function (RP); • Timing in the case of unbalance between the phases (protection U) above the value set in the configuration with protection trip set to on; • Contact wear = 100%; • Rating Plug disconnected; • Trip Coil (TC) disconnected; • Key plug error; • Current sensors disconnected.
* The IEC 60947-2 Standard defines the timing threshold L for current: 1.05 < I < 1.3 I1	

14.6.2. Electrical signals

K51/p1...p4 Programmable electrical signals if the PR120/K module or the PR021/K unit are installed and there is an auxiliary power supply.

K51/p1...p8 Programmable electrical signals if the PR021/K unit is installed and there is an auxiliary power supply.

Pressing the “i Test” key enables you to reset the activated contacts.

14.6.3. Table of error and warning messages

All the messages which can be shown on the display relating to incorrect configurations, generic alarms or deriving from the protection functions and linked to useful information are described below.

The following symbols in the warning signals have the following meanings:

= Warning signal / Protection in alarm mode, with no trip (trip=off).
= Protection in alarm mode, with trip at end of delay (trip=on).
= Information, no action, except for displaying by the relay.

Error message	Description	Notes
Harmonic dist.	Harmonic distortion alarm	Busbar currents with form factor > 2.1
Contact wear	Alarm for contact wear	Contact wear = 100%
G (TRIP OFF)	Alarm for protection G	
Gext (TRIP OFF)	Alarm for protection Gext	
T Alarm	Alarm for protection T	Temperature outside range
T (TRIP OFF)	Alarm for protection T	
U Alarm	Alarm for protection U	Protection U delay counting down
UV Alarm	Alarm for protection UV	
OV Alarm	Alarm for protection OV	
RV Alarm	Alarm for protection RV	
RP Alarm	Alarm for protection RP	

Error message	Description	Notes
UF Alarm	Alarm for protection UF	
OF Alarm	Alarm for protection OF	
Load LC1	Alarm for load control LC1	
Load LC2	Alarm for load control LC2	
L1 Sensor	Alarm for L1 phase current sensor	Phase L1 sensor disconnected or faulty
L2 Sensor	Alarm for L2 phase current sensor	Phase L2 sensor disconnected or faulty
L3 Sensor	Alarm for L3 phase current sensor	Phase L3 sensor disconnected or faulty
Ne Sensor	Alarm for Ne phase current sensor	Phase Ne sensor disconnected or faulty
Gext Sensor	Alarm for Gext current sensor	Gext sensor disconnected or faulty
TC disconnected	Trip Coil disconnected or faulty	
Rating Plug	Rating Plug Error absent or faulty	
Power factor	Power factor error	The power factor module is lower than the specified threshold
Phase cycle	Phase cycle inverted	
Invalid date	Clock information lost	
CB status	CB status error	Probable error in Q26 and/or Q27
Installation	Key plug error	
CB not defined	State of circuit-breaker inconsistent (Open/Closed)	Probable error in Q26 and/or Q27
Local Bus	Local Bus error	See par. 14.7
Contact wear	Contact wear prealarm	Contact wear ≥ 80%
L prealarm	Protection L prealarm	
T prealarm	Protection T prealarm	
Frequency range	Frequency out of range	
Warning Iw	Iw threshold exceeded	
Timing L	Timing protection L	
Timing S	Timing protection S	
Timing S2	Timing protection S2	
Timing G	Timing protection G	
Timing Gext	Timing protection Gext	
Timing D	Timing protection D	
Timing U	Timing protection U	
Timing UV	Timing protection UV	
Timing OV	Timing protection OV	
Timing RV	Timing protection RV	
Timing RP	Timing protection RP	
Timing UF	Timing protection UF	
Timing OF	Timing protection OF	

14.6.4. Error messages displayed in pop-up windows

All the messages that appear on the display in a pop-up window are described below.

Error message	Description
Password error	
Session impossible	A programming session cannot be started due to a contingency (e.g. a timer-controlled delay still elapsing)
Value outside range	Value beyond the established limits
Failed 1001/2001	Incongruence between thresholds of protectionst L ed S (SETA/SETB)
Failed 1002/2002	Incongruence between thresholds of protectionst I ed S (SETA/SETB)
Failed 1006/2006	Incongruence between thresholds of protectionst I e D (SETA/SETB)
Failed 1005/2005	Incongruence between thresholds of protectionst L e D (SETA/SETB)
Failed 1009/2009	SdZ incompatible SdZ directional

Error message	Description
Failed 1003/2003	Incongruence between thresholds of protectionst L ed S2 (SETA/SETB)
Failed 1004/2004	Incongruence between thresholds of protectionst I ed S2 (SETA/SETB)
Failed 3001	Inconsistency as to language change
Failed 3002	Inconsistency on Rc toroid
Failed 3003	Inconsistency as to external Neutral configuratione
Exception 6	Control temporarily unavailable
Unavailable	Function temporarily unavailable
Invalid date	Date has not been se
Parameters revised	Programming session concluded correctly
Cancelled	Programming session cancelled
Failed	Programming session rejected

14.7. Troubleshooting PR123/P unit

The following table lists a series of typical service conditions, to help you understand and solve hypothetical faults or malfunctions.

Note:
1. Before consulting the following table, check for any error messages appearing for some seconds on the display.
2. FN indicates the normal operation of the PR123/P.
3. In the case where the suggestions proposed do not lead to a solution of the problem, please contact the ABB SACE assistance service.

N°	Situation	Possible causes	Suggestions
1	The trip test cannot be run	1. The busbar current is > 0 2. The TC is not connected	1. FN 2. Check the messages on the display
2	Trip times lower than expected	1. Threshold too low 2. Curve too low 3. Thermal memory enabled 4. Incorrect Neutral Selection 5. The SdZ is inserted	1. Correct thresholda 2. Correct curve 3. Exclude if not necessary 4. Correct Neutral Selection 5. Exclude if not necessary
3	Trip times higher than expected	1. Threshold too high 2. Curve too high 3. Curve I^2t inserted 4. Incorrect Neutral Selection	1. Correct threshold 2. Correct curve 3. Exclude if not necessary 4. Correct Neutral Selection
4	Rapid trip, with I3=Off	Iinst tripped	FN with short-circuit with high I
5	High earth I, but no trip happens	1. Incorrect selection of the sensor 2. Function G prevented with I>4In	1. Set int. or ext. sensor 2. FN
6	Display off	1. Vaux missing and the current and/or voltage are below the minimum value. 2. Temperature out of range	1. FN, see 14.2.2.1 2. FN, see 14.2.9.8
7	The display is not back-lit	Current and/or voltages below the limit for lighting the display	FN
8	Reading of I incorrect	Current below the minimum threshold that can be displayed	FN
9	Reading of V, W and power factor incorrect	1. Connection error between VT and PR120/V 2. Voltage parameter setting error	1. Check connections between VT and PR120/V 2. Set correct parameters
10	"⚠ Local Bus" message on display	No communication between PR123/P and PR021/K	1. If not present, disable PR021/K, see 14.5.4.4.5 2. Check bus connection 3. Check PR021/K
11	Message "" instead of expected data	Function disabled or data out of range	FN
12	The expected trip does not occur	Trip function disabled	FN enable trip if necessary
13	No activation of the Unbalance U protection	Values of I out of range	FN, see 14.2.9.5
14	No display of the opening data	Vaux missing,the buffer capacitor is discharged	FN, see 14.5.6.1
15	The password is not requested	The password has been disabled	FN, re-enter the password with a value other than 0000
16	Impossible to change any parameter	PR123/P in alarm situation	FN
17	"⚠ Temp. sensor" or "⚠ Start-up" message	Possible failure inside relay	Contact ABB Sace

N°	Situation	Possible causes	Suggestions
18	Invalid date	1. First installation 2. Information lost due to power failure	FN see 14.4.3.1
19	Untimely trip		see 14.6.3
20	LED lighting		see 14.6.1
21	The language cannot be changed	1. Relay remotely set 2. CB not open 3. Vaux or PR120/V or PR030/B not installed	1. Set locally 2. Open CB 3. Power the relay

14.7.1. In the case of a fault

WARNING: If you suspect that the PR123/P is faulty, if has a malfunction or has generated an unwanted trip, it is advisable to follow the recommendations below very carefully from the Measurements menu ⟶ Historicals ⟶ Trip:

1. Make a note of the type of protection that has tripped by accessing the LAST TRIP page if there is an external power supply (Vaux or battery) or by pressing “i Test” if in self-powering mode.
2. Note down the type of circuit-breaker, number of poles, any accessories connected, In, Serial Number (see par. 14.4) and the SW version.
3. Prepare a brief description of the opening (what LEDs and/or indications were displayed? when did it happen?, how many times ?, was it always under the same conditions? what type of load? what voltage? what current? is the event reproducible?)
4. Send/communicate all the information collected, together with the circuit diagram for the circuit-breaker, to your nearest ABB Customer Support service.

The completeness and accuracy of the information given to the ABB Assistance service will facilitate technical analysis of the problem encountered, and will allow us to carry out all actions useful for the user rapidly.

WARNING: Letting a switch run with a fault that has not been remedied may lead to an apparatus malfunction or shutdown. Remove the apparatus immediately until it can be inspected or repaired if this situation may lead to personal injury, damage or is otherwise critical.

14.8. Accessories

14.8.1. ABB SACE PR010/T test and configuration unit

The test with the SACE PR010/T unit enables to check the proper operation of thresholds and tripping times of the protection functions “L”, “S”, “I”, “G”, OV, UV, RV, U. The test unit is connected to the relay by means of the dedicated connector (see par. 13.4).

14.8.2. BT030 USB communication unit

Through the BT030 USB wireless communication unit, the PR122/P can be connected via wireless to a PC, extending the information range available to the user.

14.8.3. PR021/K and HMI030 units

The PR123/P can also be connected to the PR021/K optional external indication unit (see par. 16), to signal through potential-free power contacts, the protection and trip alarms, and to the HMI030 switchboard front unit to display a number of information.

14.8.4. PR030/B power supply unit

This unit is an external unit allowing powering of Relay, Autotest and Trip Test, checking with CB open and installation of new replacement units.

14.8.5. Flex interface

Flex interfaces are electronic modules with analogue and/or digital inputs and outputs that can be fitted on a DIN guide. They can be connected to the supervision system or to the electronic release by internal bus or external bus (see par.16.6).

15. Modules

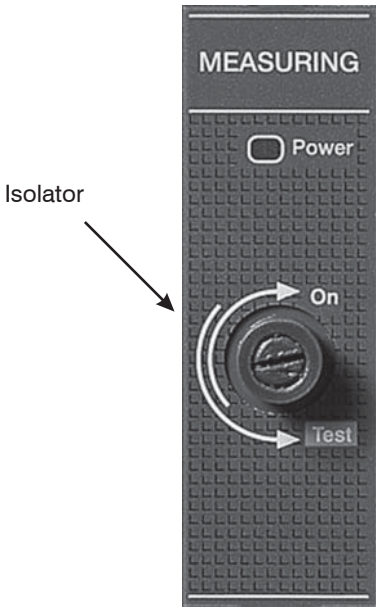
15.1. PR120/V - MEASURING Module

15.1.1. General characteristics

The MEASURING module records and processes the phase voltages. The measurements are sent by the module to the protection release, enabling the implementation of a set of protection and measurement functions. The module comes with a “Power” LED and a sealable isolator for dielectric stiffness tests. The module also enables the relay to be powered.

15.1.2. Front view

- “Power Line” LED (lit when busbar voltage is On, see 15.1.4))
- Isolator



WARNING: Before performing the dielectric stiffness test it is essential to turn the isolator into the Test position mode by turning the screw anticlockwise until you reach the end of stroke position.

WARNING: After performing a dielectric stiffness test, restore the isolator to its original position by turning it clockwise until you reach the opposite end of stroke, because all the voltage protections are disabled while the isolator is in the test position.

Dielectric strength tests on the secondary lines of Voltage Transformers connected, if any, are not allowed.

At the end of the procedure, make sure that the Power line LED is on.

15.1.3. Releases complete with the module

- standard for PR123/P
- optional for PR122/P.

15.1.4. Powering the PR122/P and PR123/P units via the PR120/V module

The PR122/P and PR123/P units are powered by the MEASURING module via the busbar voltage.
The powering stage is capable of operating starting from a voltage of 80 Vrms two-phase phase to phase up to 897 Vrms (1.3 * 690 Vrms) three-phase phase to phase at its input (coming directly from the busbars or from a transformer secondary). In the case of three-phase systems with a rated voltage greater than 690 Vrms phase to phase, a step-down transformer (with a transformation ratio of less than 1) is used. See par. 15.1.7.

The following tables show the phase-to-phase voltage values at the MEASURING module’s input for which the relays and modules are enabled:

PR122/P and PR123/P Relay + PR120/K Module

ENABLING THE UNIT AND ITS FUNCTIONS			THREE-PHASE (phase-to-phase voltage)
PR122-PR123/P Relay	PR120/K	Relay display backlighting	Enabling threshold
☒			60 Vrms
☒	☒		70 Vrms
☒	☒	☒	90 Vrms

PR122/P and PR123/P Relay + PR120/ D-BT - WL-COM Module

ENABLING THE UNIT AND ITS FUNCTIONS			THREE-PHASE (phase-to-phase voltage)
PR122-PR123/P Relay	PR120/D-BT	Relay display backlighting	Enabling threshold
☒	☒	☒	70 Vrms

PR122/P and PR123/P Relay + PR120/K Module + PR120/D-BT - WL-COM Module

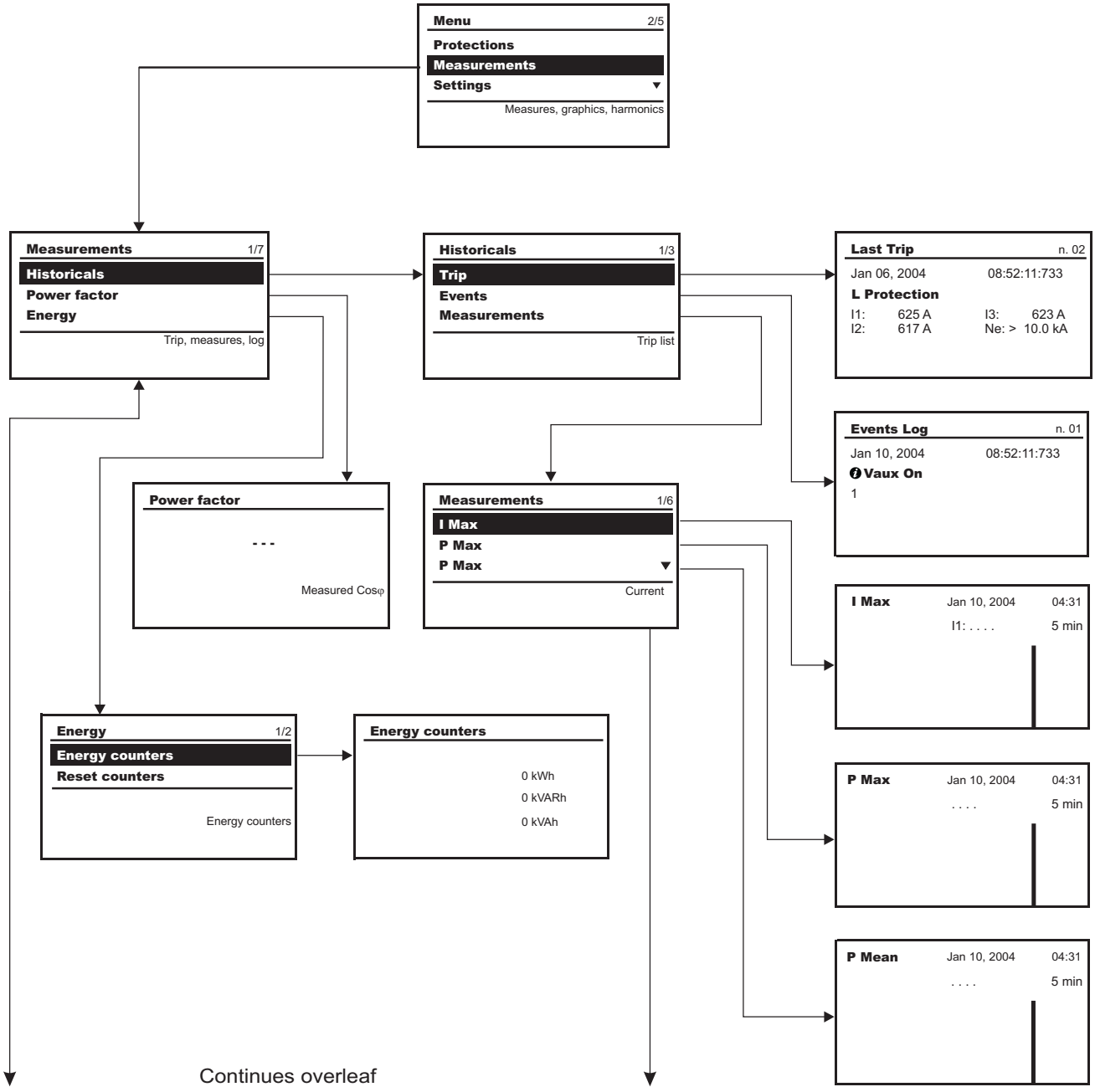
ENABLING THE UNIT AND ITS FUNCTIONS				THREE-PHASE (phase-to-phase voltage)
PR122-PR123/P Relay	PR120/K	PR120/D-BT WL	Relay display backlighting	Enabling threshold
☒	☒	☒		90 Vrms
☒	☒	☒	☒	110 Vrms

N.B.: for proper connection of PR120/V module, see figs. 43, 44 and 48 of Electric diagrams.

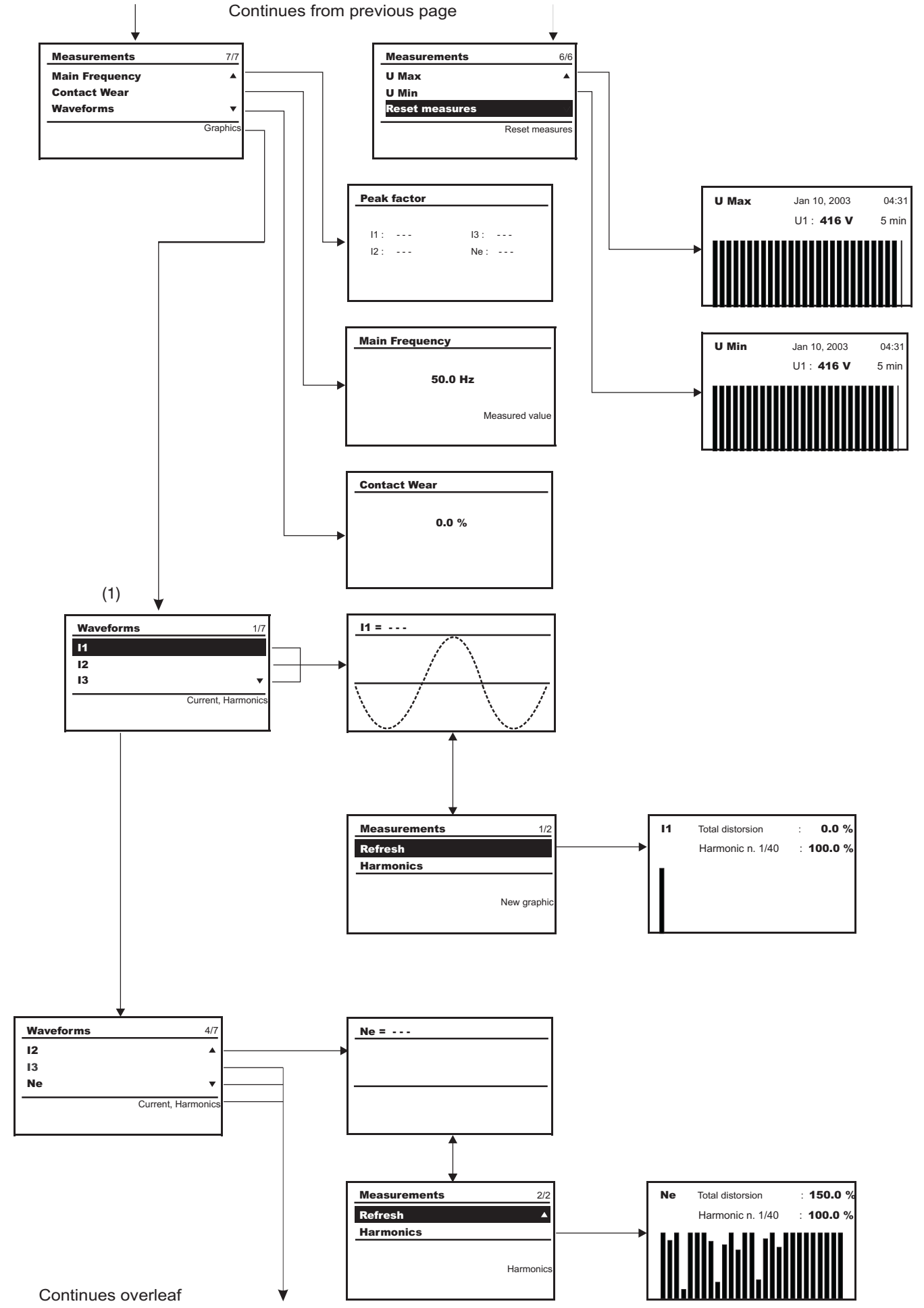
15.1.5. Operating instructions / Operation in service

15.1.5.1. Using the Measurement submenus with the PR120/V

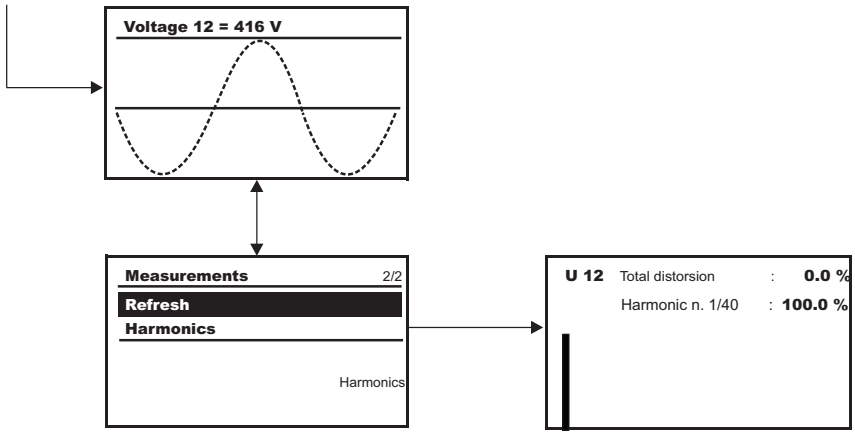
The menu for accessing the functions of the module, which is always provided on the PR123/P, but optional for the PR122/P, is illustrated below.



Continues overleaf


Continues from previous page
Measurements 7/7
Main Frequency
Contact Wear
Waveforms
Graphics
Measurements 6/6
U Max
U Min
Reset measures
Reset measures
Peak factor
I1 : - - -
I2 : - - -
I3 : - - -
Ne : - - -
U Max Jan 10, 2003 04:31
U1 : 416 V 5 min
Main Frequency
50.0 Hz
Measured value
U Min Jan 10, 2003 04:31
U1 : 416 V 5 min
Contact Wear
0.0 %
(1)
Waveforms 1/7
I1
I2
I3
Current, Harmonics
I1 = - - -
Measurements 1/2
Refresh
Harmonics
New graphic
I1 Total distorsion : 0.0 %
Harmonic n. 1/40 : 100.0 %
Waveforms 4/7
I2
I3
Ne
Current, Harmonics
Ne = - - -
Measurements 2/2
Refresh
Harmonics
Harmonics
Ne Total distorsion : 150.0 %
Harmonic n. 1/40 : 100.0 %
Continues overleaf

Continues from previous page



(1) Valid for PR123 only

15.1.5.2. Table of submenus for the PR120/V module

This menu is accessible using the path “Settings/Modules/ PR120/V module”

Parameter / Function		Values	Notes
Rated Voltage		100 V-115 V-120 V-190 V 208 V-220 V-230 V-240 V 277 V-347 V-380 V-400 V 415 V-440 V-480 V-500 V 550 V-600 V-660 V-690 V	Voltage transformer set to “Absent” For voltages below 690V
Primary Voltage		100 V-115 V-120 V-190 V 208 V-220 V-230 V-240 V 277 V-347 V-380 V-400 V 415 V-440 V-480 V-500 V 550 V-600 V-660 V-690 V 910 V-950 V-1000 V-1150 V	Voltage transformer set to “Absent” For voltages above 690V, see par. 15.1.7
Secondary voltage		100 V-110 V-115 V-120 V 200 V-230 V	
Power flow		Bottom → Top Top → Bottom	
Signals(1)	Phase sequence Enabling status Threshold	ON/OFF 123/321	can be set when Enabling is set to ON
	Cosφ Enabling status Threshold	ON/OFF from 0,5 a 0,95 step 0,01	can be set when Enabling is set to ON

(1) -Valid for PR123 only

15.1.5.3. Measurements Menu table

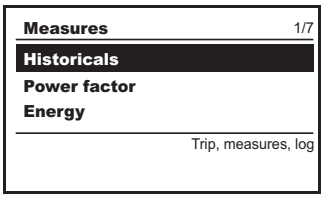
For the sake of simplicity, the table refers to the Measurements menu already provided in the PR123/P, which is also applicable for the PR122/P fitted with a PR120/V module

	Parameter / Function	Values	Notes
Historicals	Trips Events Measurements Maximum current Maximum active power Mean active power Maximum voltage Minimum voltage Reset measurements Mean power		List of trips Events log
Power factor			Measured cos φ Available in self-supply mode
Energy	Energy meters Reset meters		
Peak factor			Peak value/rms value Available in self-supply mode

	Parameter / Function	Values	Notes
Mains frequency		50-60 Hz	Measured value Available in self-supply mode
Contact wear			Percentage of contact wear
Waveforms	Current I1/I2/I3/Ne Refresh Harmonics Voltage 12/23/31 Refresh Harmonics		

15.1.5.4. Measurements Menu

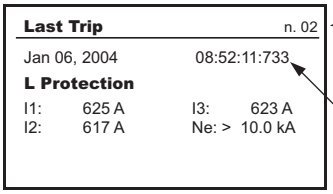
15.1.5.4.1 Historicals



A whole range of measurements is accessible from the “Measurements/Historicals” menu.

15.1.5.4.2 Trips

The following is an example of a page showing the latest trip. You can access said page by selecting Trips via the path Measurements / Historicals / Trips. The page shows the values for the type of protection that has been tripped (L in the example).

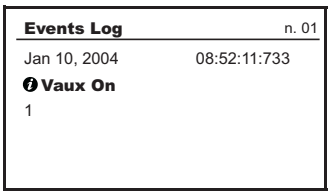


Meter: counts progressively (0 … 65,535) as of the date of the latest trips reset. It shows the latest 20 trips which can still be selected.

Time (in hours and minutes) when CB opened

15.1.5.4.3 Events

The following table shows a typical page concerning the latest events Log. You can access said page by selecting Events via the path Measurements / Historicals / Events.



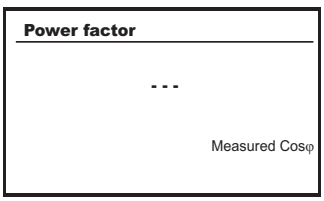
Meter: indicates “Last” and measures the previous ones according to a -1, -2 up to -80 progression (e.g. second-last -1)

15.1.5.4.4 Measurements

This menu is for showing the following measurements:

I Max - Maximum current
P Max - Maximum active power
P Mean - Mean active power
U Max - Max line voltage (phase-to-phase)
U Min - Min line voltage (phase-to-phase)
Reset - Reset measurements

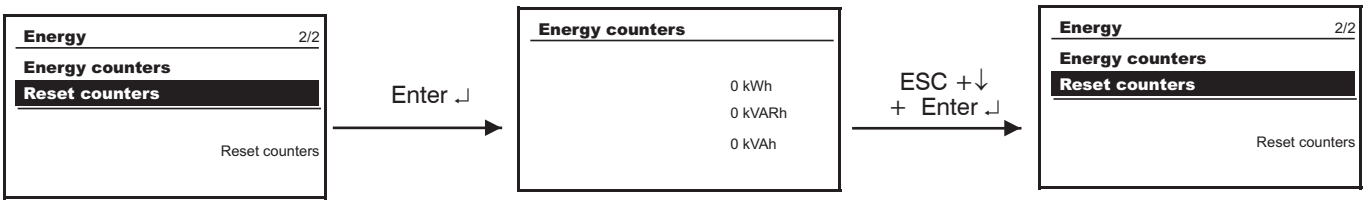
15.1.5.4.5 Power factor



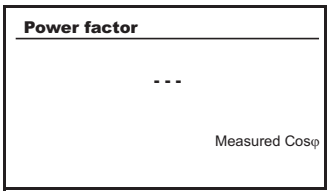
The unit provides the measurement of the global power factor. For phase power under 2% ($0.02xPn_{phase}$) the value is not displayed, but is replaced by ‘…..’.

15.1.5.4.6 Energy

The unit also provides meter readings of the total active, reactive and apparent energy of the system. The minimum value that can be displayed is 0.001 MWh or 0.001 MVARh or 0.001 MVAh. The energy meters' end of scale is approximately 2.15 billion kWh / kVARh / kVAh.
The meter can also be reset by pressing the "Reset meters" key on the menu.
For the ranges and precisions see par.14.2.9.15.

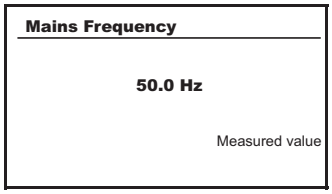


15.1.5.4.7 Peak factor



On this page you can also measure the peak factor - i.e. the relationship between I_{peak} / I_{rms}, - for each of the phases. This measurement is not displayed for phase currents below 0.3xIn and it is not available for phase currents above 6xIn. For the ranges and precisions see par. 14.2.9.15.

15.1.5.4.8 Mains frequency

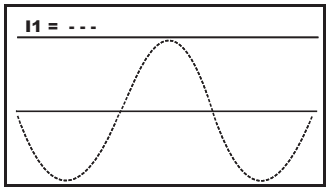


This page enables you to view the mains frequency. This is calculated on the voltages (if Umax > 0.1Un).
For the ranges and precisions see par. 14.2.9.15.
The measurement is guaranteed a maximum of 5s after the change in frequency.

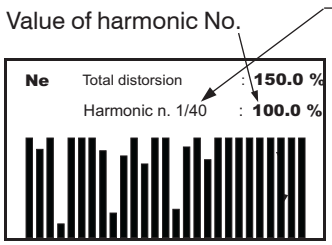
15.1.5.4.9 Contact wear

This submenu shows the percentage of wear on the CB contacts.

15.1.5.4.10 Waveforms



When you access this menu page, 120 samples of the wave form of the selected phase are acquired and displayed.
When you press the ↵ key, a new wave form is acquired and displayed ↑ or ↓ keys, you can display the waveforms of the following measurement channels (L1, L2, L3, Ne, V1, V2, V3, Gt).



You can analyze the harmonic of the samples acquired and displayed on the "Waveforms" page, i.e. the page on the left is displayed, containing the module of the harmonics from the 1ª to the 40ª (up to the 35ª for a mains frequency set to 60Hz) given as a percentage of the fundamental (harmonic no. 1), which is consequently always given as 100%.

Using the ↑ or ↓ keys you can go to the bar of interest (at the "No." of harmonic required, the bar begins to flash) and read the corresponding percentage value.
The measurement precision is 5%.

15.1.6. Data Logger

The data logger is active both with Vaux and with a power supply from the PR120/V.
For further information, see par. 16.3.

15.1.7. Electrical characteristics of the transformers

If the phase-to-phase line voltage is greater than 690Vac, it is essential to use a step-down transformer between the bars and the PR120/V module. Voltage transformers can be installed up to 15m away from the PR120/V module to which they are connected. Proper operation is only guaranteed for star/star or delta/delta configurations.
The allowable primary and secondary rated voltages that must be set on the unit are specified in the table 15.1.5.2.

Mechanical characteristics	
Fixture	DIN rail EN 50022
Material	self-extinguishing thermoplastic
Degree of protection	IP30
Electrostatic protection	shielded towards EARTH

Electrical characteristics	
Precision class	cl. 0,5
Performance	≥10VA...≤20 VA
Overload	20% permanent
Insulation	4 kV between inputs and outputs
	4 kV between inputs and outputs
	4 kV between inputs and inputs
Operating frequency range	from 50 Hz to 60 Hz, ± 10%

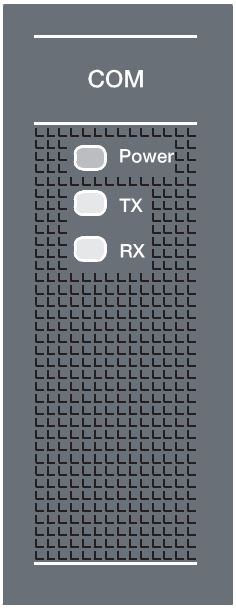
15.2. PR120/D-M - COM communication module

15.2.1. General characteristics

Dedicated communication module for connecting the relay to a Modbus net, and for remote supervisory and control activities on the circuit-breakers.

15.2.2. Front view

- “Power” LED (lit when Vaux is installed)
- LED RX/TX (data send/receive signal)



15.2.3. Releases complete with the module

- optional for PR122/P
- optional for PR123/P

15.2.4. Power supply

The PR120/D-M - COM communication module is only powered by the relay if there is a 24V auxiliary voltage available.

15.2.5. Connection

Refer to fig. 45 in the wiring diagram provided in this manual.

15.2.6. Communication functions available

The communication function on the PR122/P, PR123/P releases with PR120/D-M - COM is listed in the table:

PR122/P or PR123/P + PR120/D-M - COM

Protocol	Modbus RTU
Physical interface	RS-485
Baud rate	9600 - 19200 bit/s

15.2.7. PR120/D-M - COM module menu

Parameter / Function	Values	Notes
Local/remote	Local/remote	
Serial address	1 ... 247	247 default address
Baudrate	9600 bit/s 19200 bit/s	
Physical protocol	8,E,1 - 8,0,1 - 8,N,2 - 8,N,1	
Addressing	Modbus standard ABB	

15.3. PR120/K signalling module

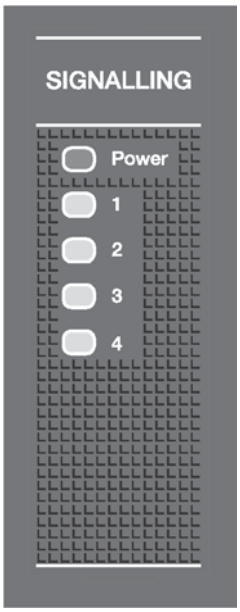
15.3.1. General characteristics

The module enables the local signalling of alarms and circuit-breaker trips.
There are two possible configurations for the SIGNALLING module:
- default configuration: 1 digital input, 3 contacts with pole in common, 1 independent contact;
- alternative configuration: 4 independent contacts. In this case, the digital input is wired, but not brought up to the terminal block.

The two configurations are alternative to each other. You can switch from one configuration to the other without changing the module, by using a different wiring, as illustrated in the wiring diagrams in figs. 46 or 47.

15.3.2. Front view

- “Power” LED (lit when Vaux or PR120/V are installed)
- N° 4 LED: associated with the signalling contacts.



15.3.3. Releases complete with the module

- optional for PR122/P
- optional for PR123/P

15.3.4. Characteristics of the digital input

The unit enables the digital input to be associated with the following functions:
- enabling of an alternative set of parameters, set B (PR123/P only);
- outside trip control;
- zeroing release trips;
- resetting PR120/K contacts;
- local/remote enabling;
- resetting energy meters.

The digital input is activated by a 24VDC + 20% voltage.
For the load control function, the module can be used as an actuator.

15.3.5. Characteristics of the signalling contacts

The following data are defined for resistive loads (cos $\varphi = 1$)

Type of contact	**SPST**	
Max switching voltage	130 VDC	380 VAC
Max switching current	5 A	8 A
Max switching power	175 W	2000 VA
Breaking capacity at 35 VDC	5 A	----
Breaking capacity at 120 VDC	0,2 A	----
Breaking capacity at 250 VAC	----	8 A
Breaking capacity at 380 VAC	----	5,2 A
Contact/coil insulation		4000 Vrms
Contact/contact insulation		1000 Vrms

15.3.6. Power supply

The PR120/K signalling module is powered in auxiliary mode by the relay and/or by the PR120/V as specified in chapter 15.1.

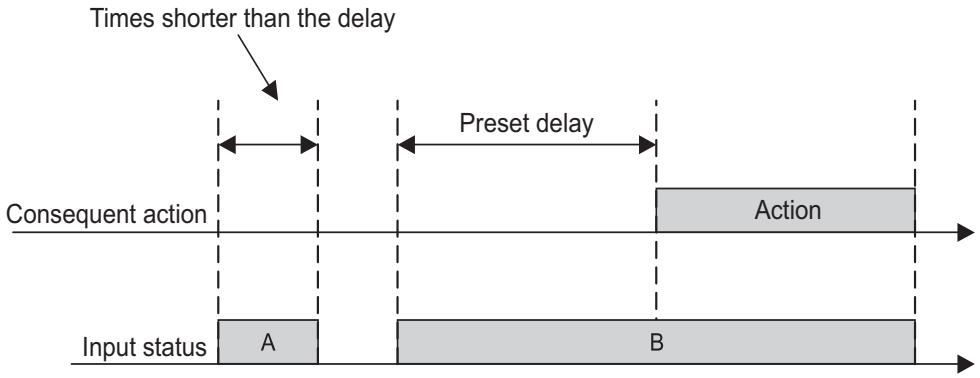
15.3.7. PR120/K module menu

The PR120/K is fitted with four relays having contacts named K51/p1, K51/p2, K51/p3 and K51/p4 which can signal different situations selectable by the user from among those given in the standard list, whereas customizations can be programmed by selecting “custom” on the menu and setting the signal required with a PDA, SD-Testbus or PR010/T.
See Appendix 16.4.

	Parameter / Function	Values	Notes
Relay no. 1...4 (K51/p1...p4)	Signal source	Standard or custom	- see par. 16.5
	Delay	0...100s step 0,01s	- Deliberate delay before activating the contact
	NO/NC	NO/NC	- Contact normally-open (NO) or normally-closed
	Latch	ON/OFF	- With the contact “ON”, once it has been activated it stays switched. A specific reset action is needed to reset it
Input	Polarity	Active low	
		Active high	
	Function	Generic	- No associated action
		Outside trip	- Releases the circuit-breaker
		Reset trip	- Resets the data after a trip
		Set B	- Switches from set A to set B (for PR123/P only)
		Local	- Forces the local status of the protection (local/remote)
		Signal reset	- Programmable contact reset
		Energy reset	- Energy meter reset
	Delay	0...100s step 0,01s	- Performs action after t is set

15.3.8. Configurable input

There is an input with a configurable function in the Signalling module. The figure shows two cases, A and B, in which the input’s status is active; in case A the input does not stay valid beyond the enabling delay so the associated action does not take place, whereas in case B the action takes place after the preset delay.



15.3.8.1. Input configuration settings

You can select the level at which to consider the input enabled:
1. low input enabling level
2. high input enabling level

15.3.8.2. Input function settings (ACTION)

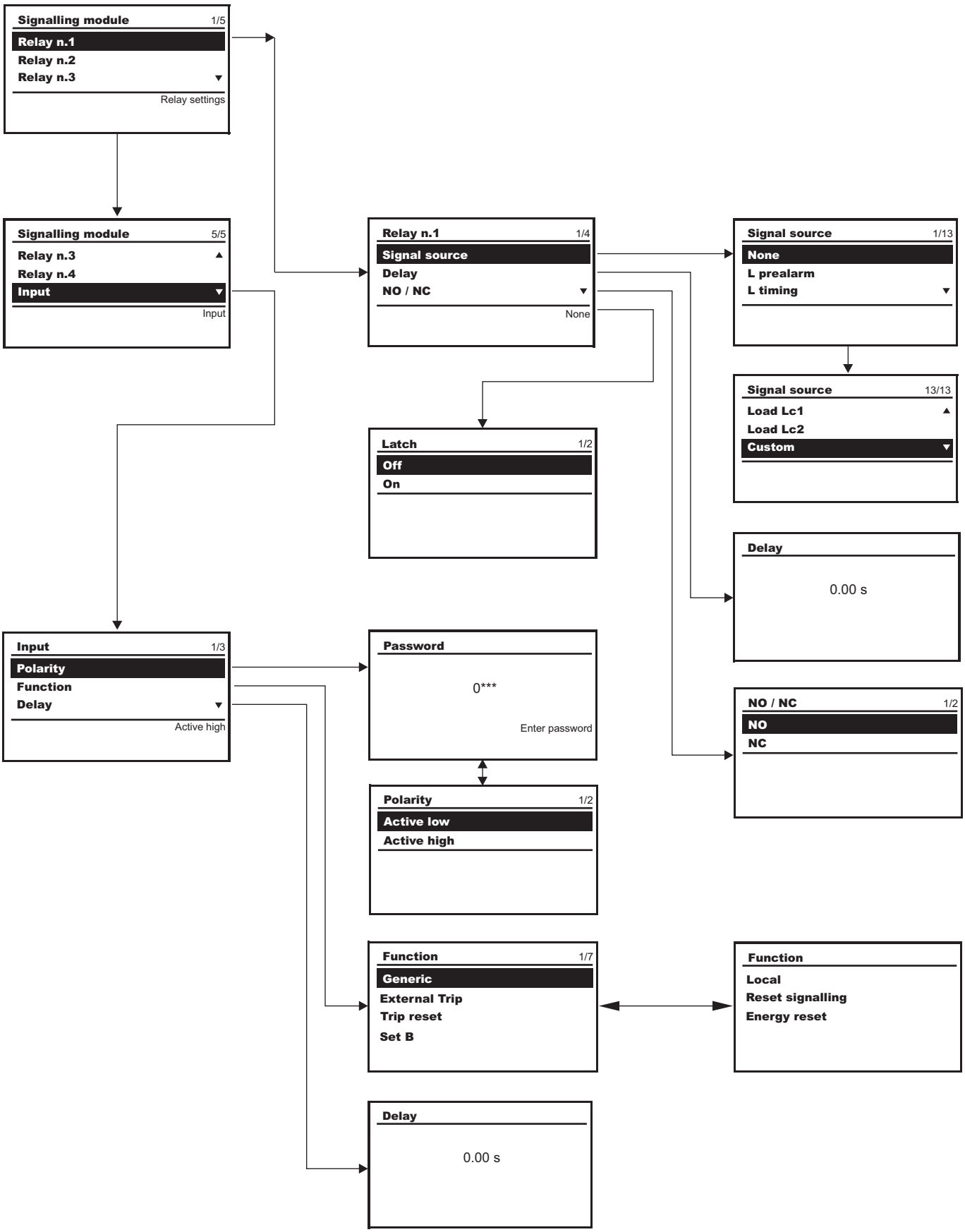
You can select the action associated with the input, i.e. the action that takes place after the programmed delay, when the input is enabled (on high or low level).
You can select one of the following actions:
1. Generic: no specific action is associated with the input. The status of the input is shown on the available display and remotely via the bus
2. Trip test: when the input is enabled for the specified delay, a trip test is performed
3. Trip reset: when the input is enabled for the specified delay a trip reset is performed
4. Set B: when the input is enabled for the specified delay, the Set B is enabled
5. Dial Local: when the input is enabled for the specified delay, there is a forcing of the dialogue local mode
6. Signalling module reset: when the input is enabled for the specified delay, the status of the relays in the PR120/K module is reset
7. Energy reset: when the input is active for the specified delay, the energy meters are reset.

15.3.8.3. Setting the input enabling delay

By means of the “Delay” parameter, you can specify the time elapsing before the input is enabled in the range 0.00 [s] to 100.00 [s] with 0.01[s] steps.

15.3.9. PR120/K module menu layout

The menu layout relating to relay no. 1 (K51/p1) is shown below as an example; the same applies to the menus for the other relays.



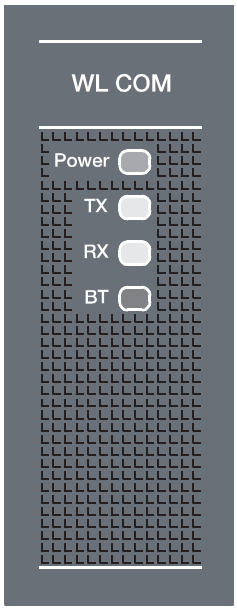
15.4. PR120/D-BT - WL-COM wireless communication module

15.4.1. General characteristics

This module enables wireless communication between the protection releases and a handheld PC (PDA) or a laptop with a Bluetooth port.

15.4.2. Front view

- “Power” LED (lit with Vaux or PR120/V installed)
- LED Rx/Tx (send/receive signal)
- LED BT (Bluetooth link enabled



15.4.3. Releases complete with the module

- optional for PR122/P
- optional for PR123/P

15.4.4. Power supply

The PR120/D-BT WL-COM module is powered in auxiliary mode, from the PR120/V module, as specified in the description of the module, or by a PR030/B power supply unit.

15.4.5. Connection

For a proper connection, bear in mind that the module’s range of action is 10 meters in air.

16. Appendices

16.1. PR021/K outside signalling unit

16.1.1. General information

The signalling unit converts the digital signals provided by the protection units into electrical signals by means of normally-open electric contacts.
Information on the status of the protection functions transits on a dedicated serial line connected to the release.
The following signals/contacts are available:
- L overload prealarm (the alarm signal remains enabled throughout the overload, until the release has been tripped)
- protections timing and trip (the protections trip signal remains enabled during the timing-controlled phase and after the release has been tripped)
- I protection trip
- timing and overheating threshold overrun
- two contacts for load control
- release trip
- communication error on serial line (connections between protection and signalling units)
- phase unbalance.

By setting the DIP switches, you can configure the signals of 7 programmable contacts, This can be done by selecting them directly in the PR121 relay via PR010/T or SD-Testbus 2; PR122/P or PR123/P relay, choosing from a long list, including: directional protection trip D, minimum and maximum voltage trip UV and OV, reverse power trip RP and others.

Two contacts available on the SACE PR021/K (load control) unit enable you to control a release for opening and closing the circuit-breaker. These contacts enable various applications, including load control, alarms, signals, electric cutouts.
A Reset button enables you to zero the status of all the front optical signals and return the relays' contacts to the resting position.
The unit also contains ten LEDs to display the following information:
- Power ON: auxiliary power supply on
- Tx(int Bus): flashing synchronized with dialogue with the Internal Bus
- Eight LEDs associated with the signaling contacts.

16.1.2. Power supply

Auxiliary power supply	24 V DC +/-20%
Maximum ripple	5%
Rated power @ 24 V	4,4 W

16.1.3. General characteristics of the signalling relays

The following data are defined for resistive loads (cos φ = 1)

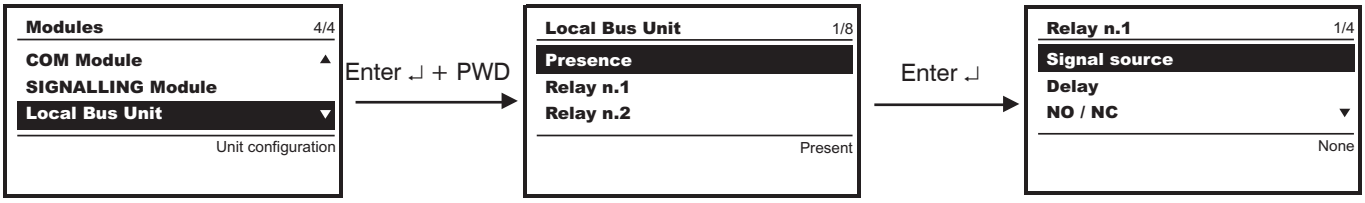
Type of contact	**SPST**	
Maximum switching voltage	130 VDC	380 VAC
Maximum switching current	5 A	8 A
Maximum switching power	175 W	2000 VA
Breaking capacity @ 35 VDC	5 A	----
Breaking capacity @ 120 VDC	0,2 A	----
Breaking capacity @ 250 VAC	----	8 A
Breaking capacity @ 380 VAC	----	5,2 A
Contact/coil insulation		4000 Vrms
Contact/contact insulation		1000 Vrms

16.1.4. Relay functions

The available contacts can be used to manage the respective relays indicating an event (a given situation in the state of the device) that prompts the required relays to be independently enabled after the delay specified by the user. The function is entirely similar to the one described in the PR120/K signalling module in par. 15.3 and 16.4 of this manual.

16.1.5. PR021/K signalling unit menu

The unit's functions are accessible from the operator panel (PR123/P and PR122/P where applicable)



16.1.5.1. PR021/K unit menu table

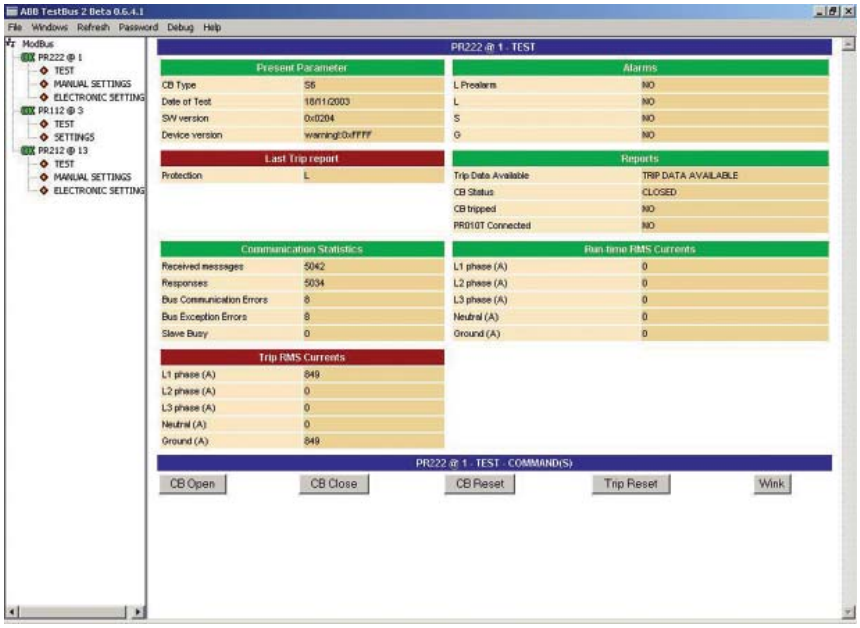
Protection	Parameter / Function	Values	Notes
PR021K unit		Present	
		Absent	Leave as Absent if there is no PR021/K
	Relay no. 1 / 2 / 3 / 4 / 6 / 7 / 8 Signal source function		
		None	
		L Prealarm	
		L Timing	
		S Timing	
		L Trip	
		S Trip	
		G Trip	
		I Trip	
		Any trip	
		Custom	- See par. 16.3.3
	Delay	0...100 s step 0,01s	- Deliberate delay before activating the contact
	NO/NC	NO/NC	- Contact normally-open (NO) or normally-closed (NC)
	Latch	ON/OFF	- With the contact “ON”, once it has been activated it stays switched. A specific reset action is needed to reset it

16.1.5.2. Important note

WARNING: The unit must be connected to the PR122/P or PR123/P by means of an internal busbar with a shielded, corded two-wire cable (see note A, par. 11.2.2) no more than 15 m long.
The shield must be earthed both on the circuit-breaker side and on the PR021/K side. For the installation and operation of the PR021/K accessory, refer to the specific user manual.

16.2. SD-Testbus2

SD-TestBus2 is the installation and diagnostic software for ABB SACE products with a Modbus RTU communication. It can be used during commissioning, or to find faults in an already up and running communication network.
This enables the connection to a PR121/P, PR122/P and PR123/P.
SD-TestBus2 runs an automatic scan on the RS-485 bus, recording all the devices connected and checking their configurations, and also testing all the possible combinations of addresses, parity and baud rate.
With a simple click on SCAN you can pinpoint the devices that fail to respond, the configuration errors, the wrong addresses and parity errors, and so on.
After scanning, the software shows warning messages on potential problems or configuration errors, enabling a complete diagnosis of the communication network. These functions are not limited to the ABB SACE devices: any apparatus using the Modbus RTU standard protocol is recorded and tested.
For the ABB SACE circuit-breakers with an electronic release, the software provides a vast range of additional functions, for checking the wiring, setting opening, closing or reset commands, and reading diagnostic information.
This program is so easy to use that it guarantees a trouble-free installation and commissioning of a Modbus communication network.
SD-TestBus2 is distributed free of charge (freeware) and can be downloaded from the BOL site (http://bol.it.abb.com).



Ekip connect, the new diagnostic software for ABB Sace products, will soon be available.

16.3. Data Logger (recorder)

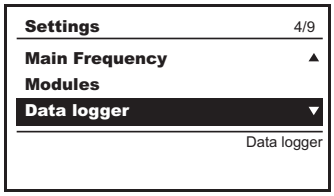
The data logger function is available on the PR122/P and PR123/P units and it can be used to save the instantaneous values of certain analog and digital measurements automatically in a large-sized memory buffer. The data can easily be downloaded from the unit using either the SD-TestBus application via a Modbus bus, and transferred to any personal computer for processing. The function stops the recording every time a trip occurs in order to facilitate failure analysis.

16.3.1. General characteristics

Number of analogue channels:	7
Number of digital events:	64
Maximum sampling frequency:	600 ... 4800 Hz
Sampling time	3 ... 27 s (depending on frequency of 600 Hz sampling)

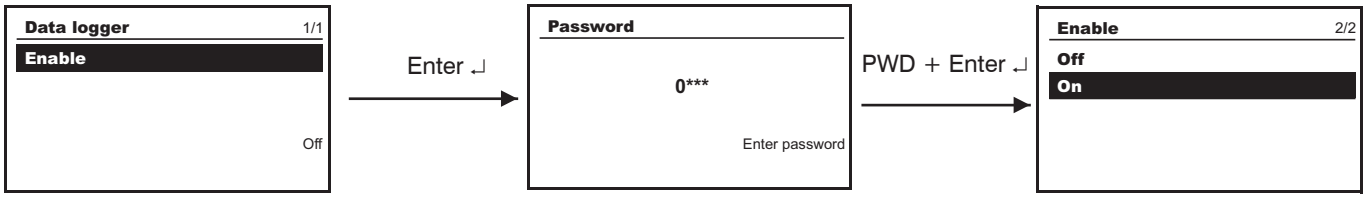
16.3.2. Description of the Data Logger menu

You can access the data logger menu from the Settings menu in the PR122/P and PR123/P units:



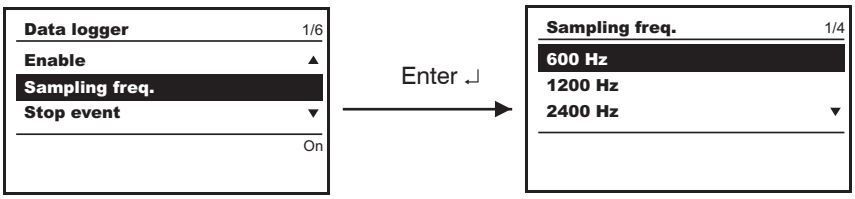
16.3.2.1. Enabling the Data Logger

The data logger can be enabled by inputting a password:



16.3.2.2. Setting the sampling frequency

On the menu, you can specify the frequency with which the measurements are saved, choosing from 4 fixed frequencies, i.e. 600 Hz, 1200 Hz, 2400 Hz or 4800 Hz.



The maximum data recording times (see also par. 16.3.3) depend on the selected frequency and are illustrated in the following table:

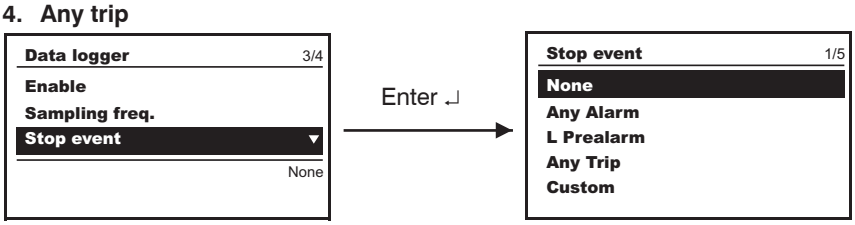
Frequency	RECORDING TIME
600 Hz	27,3 s
1200 Hz	13,6 s
2400 Hz	6,8 s
4800 Hz	3,4 s

Note: Selecting sampling frequency is an important step. In fact, presence of high-order harmonic waves may cause aliasing on processing of collected data. Use maximum frequency when a harmonic distortion is available, otherwise data processing may give results which do not match actual system conditions.

16.3.2.3. Setting the standard stop events (triggers)

You can select one of the following stop events (triggers), see also par. 16.4.2:

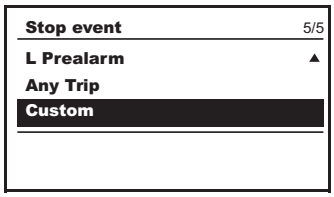
1. **None**
2. **Any alarm**
3. **L timing**
4. **Any trip**



If you select “None” for the stop event, the data logger can be stopped only by a stop command from the operator panel, from the system or following a trip generated by the relay.

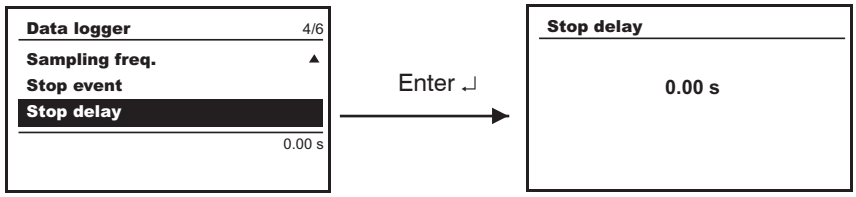
16.3.2.4. Setting and viewing customized stop events (triggers)

From the system, you can set customized stop events (triggers) to coincide with the events shown in paragraph 16.4.
In the event of a customized trigger point, the following window is displayed:



16.3.2.5. Setting the stopping delay

The stopping delay can be set between 0.00 [s] and 10.00 [s], in 0.01 [s] steps.



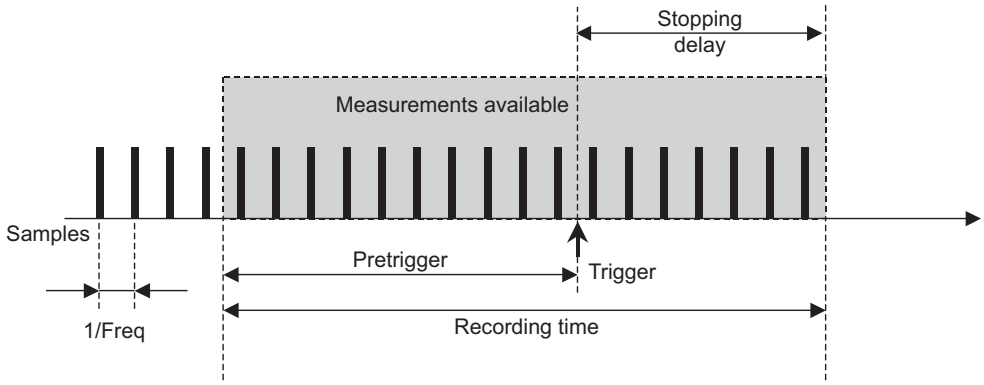
WARNING: In the event of a trip, this data storage process is stopped after 10 ms, even if a longer stopping delay has been selected.

16.3.2.6. Restart/Stop Data Logger

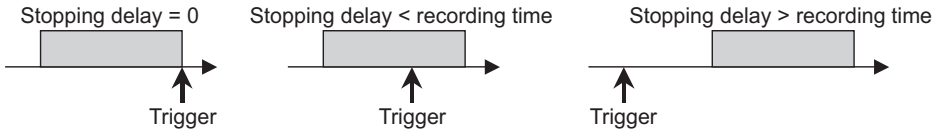
Using the Restart/Stop options, you can restart or stop the recording by the data logger:

16.3.3. Recording time windows

The data logger's measurements are recorded in a time window, the duration of which is defined and synchronized by an event (trigger/stop event) of your choice.
The following figure displays the time window, the trigger and the samples available in gray:

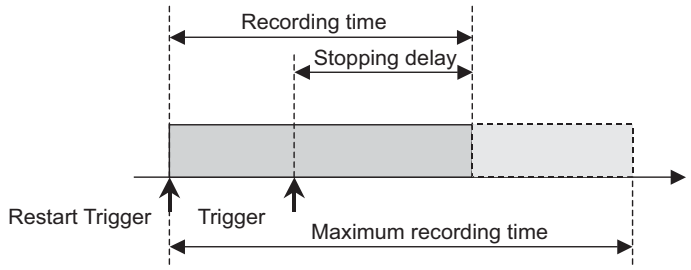


The user can select the sampling frequency (see par. 16.3.2.2), the type of stop trigger event (see par. 16.3.2.3) and the stop delay (see par. 16.3.2.4) so as to obtain the desired pre-trigger for the selected event.
Depending on the set value, the stop delay can be nil, or less or more than the recorded duration, as shown in the figure below:



WARNING: If datalogger parameters are changed whilst the datalogger is active, the storage that is in progress will be terminated and new storage will start on the basis of the new parameters (following a trigger restart command).

Maximum recording time is established by the sampling frequency set only, as described in the table in paragraph 16.4.2.2; recording time may be lower than maximum time attainable when the sum of stopping delay and time elapsing between a restart trigger and a trigger is lower than the maximum value, as described in the figure below:



16.3.4. Description of the information given by the Data Logger system

16.3.4.1. Combination of devices for reading/setting data from the Data Logger system

By connecting to the release's outside bus, you can set certain data logger parameters, triggers or commands, or read certain types and sequences of data in its memory.

The combinations of devices and the consequent software combinations that enables these functions are as follows:

1) **PR122/P + BT030 USB**
2) **PR122/P + PR120/D-M + SD-Testbus or remote system**
3) **PR122/P + PR120/D-BT**
4) **PR123/P + BT030 USB**
5) **PR123/P + PR120/D-M + SD-Testbus or remote system**
6) **PR123/P + PR120/D-BT**
7) **PR122/P + PR010/T ***
8) **PR123/P + PR010/T ***

* With these combinations it is impossible to download sequences of stored data

In this manual, the term "from the system" is used to define both the operations that are carried out using one of the combinations with SD-Testbus, and the operations that involve connecting to a remote system.

16.3.4.2. Access to saved data from the system

When the event associated with the stop event occurs or a stop command is received, the following data are saved in the recording block:

- Data logger Trigger, which indicates the type of stop event (trigger) that has prompted the stoppage of the data logger;
- Time-stamp of the stop event (trigger) (day/hour + minutes/seconds/milliseconds)(4 words);
- Data logger max file, which indicates which is the max file with consistent data;
- Data logger max address, which indicates the max address number of a block with consistent data.

The following information is recorded in the block for each sampling period:

1. **current sample L1**
2. **current sample L2**
3. **current sample L3**
4. **current sample Ne**
5. **voltage sample U12**
6. **voltage sample U23**
7. **voltage sample U31**
8. **digital inputs/outputs (among 16 possible options, e.g. inputs/outputs for Zone Selectivity, PR120/K contact status, ...)**
9. **alarms1 (among 16 possible options, e.g. L timing, G alarm, Prealarm)**
10. **allarmi2 (tra 16 possibili. Es: UF timing, OV timing, Frequency error, RP timing)**
11. **trips (among 16 possible options, e.g. tripping of L, S, I, G, UV, OF, ...)**

16.3.4.3. Information from the system on the configuration and status of the Data Logger

The following information is provided on the status of the data logger:

STATUS	
Waiting trigger:	this means that the data logger is enabled and waiting for the occurrence of the event selected as the trigger.
Data Logger triggered:	this indicates that the trigger event has occurred and the data logger is still recording.
Data Logger stopped:	this means that the recording has been terminated either because it has been completed or because a data logger stop command has been received, or because a trip has occurred.

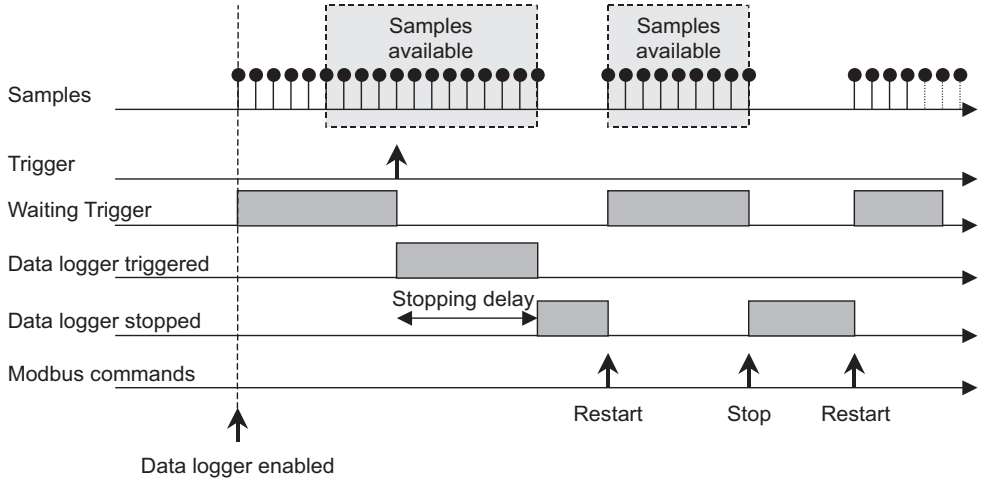
CONFIGURATION	
Data Logger Config:	indicates whether or not the data logger is active
Data Logger Trigger Type:	indicates the stop event (trigger) setting
Data logger stopping delay:	indicates the delay for the stop

16.3.5. Data logger commands from the system

When a data logger stop command is given, the recording is stopped from the system. The subsequent recording is enabled by a Restart trigger command. The same applies to the operator panel, as illustrated in par. 16.4.2.6.

Example of data logger operation

The following figure shows an example of how a trigger works, the data logger's function, the effect of the stopping delay and of the restart and subsequent stop commands on the data saving procedure



16.4. Table showing list of events

16.4.1. "Standard" events for PR120/K and for PR021/K selectable from the relay

Event no.	Description	
0.	None	(none enabled)
1.	L prealarm	(L protection prealarm)
2.	L timing	(L protection timing)
3.	S timing	(S protection timing)
4.	L trip	(L protection trip)
5.	S trip	(S protection trip)
6.	I trip	(I protection trip)
7.	G trip	(G protection trip)
8.	Any trip	(tripping of any protection)

16.4.2. "Standard" events for the Data Logger function, selectable from the relay

Event no.	Description	
0.	None	(free running)
1.	Any alarm	(any alarm)
2.	L timing	(L protection timing)
3.	Any trip	(tripping of any protection)

16.4.3. Examples of “Custom” events for the Data Logger function, for PR120/K and PR021/K

No. (decimal)	Event	Notes	PR122	PR123
1920	G timing		x	x
2894	L1 or L2 or L3 sensor error or Trip Coil error		x	x
2688	LC1 alarm		x	x
2049	G alarm		x	x
2306	UV timing		x	x
4124	UV or OV or RV tripped		x	x
33672	CB connected and springs charged		x	x
1793	Harmonic distortion > 2,1		x	x

You can combine the status bits with “and”/“or” logical functions within the same group of events (byte). For more detailed information, refer to the Modbus Interface document.

16.4.4. Combining the devices needed to customize settings

The “custom” events can be selected using a remote control system SD-TestBus.
The devices you need to enable you to do so can be selected from among the following:

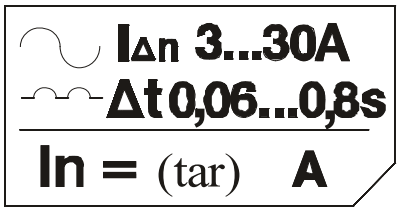
1) **PR122/P + BT030 USB**
2) **PR122/P + PR120/D-M + SD-Testbus or remote system**
3) **PR122/P + PR120/D-LV**
4) **PR122/P + PR010/T**
5) **PR123/P + BT030 USB**
6) **PR123/P + PR120/D-M + SD-Testbus or remote system**
7) **PR123/P + PR120/D-LV**
8) **PR123/P + PR010/T**

16.5. Residual current protection function Rc

16.5.1. General

EMAX circuit-breakers can be equipped with a toroid fitted at the rear of the CB (at a max distance of ten meters) so as to ensure protection against residual current ground faults.
In particular, the electronic releases which can ensure this function are as follows:
- PR122/P LSIRc,
- PR122/P LSIG fitted with a PR120/V module
- PR123/P LSIG.

The residual current protection function is available only in the event of a dedicated rating plug which carries sensitivity ranges and non-trip times characterizing this function.



The following table shows the available settings:

Available Settings
400
630
800
1250
2000
3200

The following table shows protection thresholds and times that can be set:

Thresholds	Non-trip times
3 A	0,06s
5 A	0,10s
7 A	0,20s
10 A	0,30s
20 A	0,40s
30 A	0,50s
	0,80s

Two toroidal sizes are available: the small toroid can be installed on E1 and E2 three-pole sizes, the medium toroid can be installed on E1 and E2 four-pole sizes and on E3 three-pole sizes.
The PR122/P LSIRc unit provides all PR122/P LSI functions but with one addition: protection against residual current faults.
Using PR122/P LSIG with additional PR120/V module, the protection against residual current is added to a unit having the characteristics of a PR122/P LSI and all additional ones described for the PR120/V module, see par. 15.1.
With a PR123/P LSIG unit, the Rc protection function replaces the external G function (Gext); however, G function is retained.

WARNING: The Rc protection is activated only when a rating plug dedicated to Rc function is available, and after correctly performing the unit installation procedure.
This protection cannot be disabled.

16.5.2. Putting into service

The PR122/P LSIRc unit comes already configured.
However, when a PR122/P LSIG or PR123/P LSIG units are used, follow the directions below to update the unit:

1. Disconnect all power supplies;
2. Replace the rating plug with one supplied by SACE for Rc application;
3. Install the toroid on the busbars as shown in the 1SDH000601R0001 document;
4. Connect the toroid to the release as per the wiring diagram on page 153;
5. Power the unit through PR030/B and proceed to installation according to the following path: settings, CB, earth protection, external toroid, RC. Confirm the changes;
6. Check that no failures are indicated;
7. Set threshold and times of Rc protection;
8. Conduct an Rc test, see par. 16.6.3; check for correct operation.

16.5.3. Rc test menu

The test page of Rc protection can be accessed by pressing the “iTest” key for 7 seconds, or else the Rc test page can be reached through the following path: test; Rc (Idn). Rc test screen will be displayed; press the “iTest” key again to test.
A successful result will be proved by CB opening within the times previously set.

WARNING: In the event of a fault related to the connections between toroid and protection unit, the wording: ⚠ GText sensor, will be displayed.

16.6. Flex interface

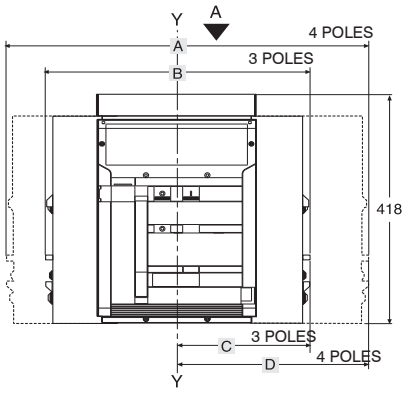
Flex interfaces are electronic modules that can be fitted on a DIN guide, with analogue and/or digital inputs and outputs and can be connected to the supervision system (Master) or to the electronic release by a local bus.
The family of Flex interfaces consists of devices connected to the system bus (SD) and of accessories connected to the local bus and to the release by MM030 (AD)

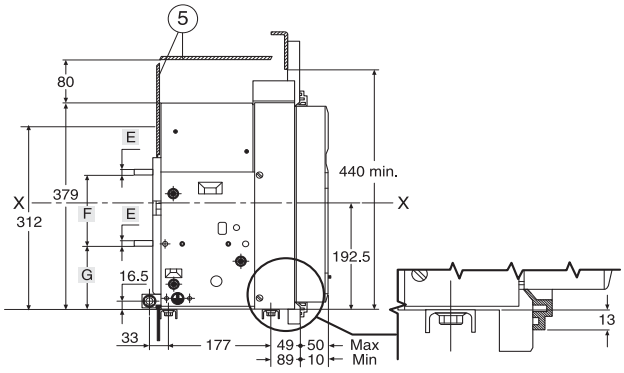
	Device	Features	Description	Notes	Reference documentation
	HMI030	Display	Displays data received from the disconnector or from MM030	note 1:by appropriate configuration it can be connected to the disconnector or directly to MM030	1SDH000573R0001
				note 2: the HMI030 connection with MM030 is possible for MM030 software versions starting from 2.0	
	MM030		Manages the information exchanges between the disconnector and the accessories of the Flex interface family		1SDH000622R0001
SD	SD030 DO	8 digital inputs	Receives information from the master and actuates its digital outputs accordingly		1SDH000649R0001
	SD030 AO	4 analogue outputs	Receives information from the master and actuates its analogue outputs accordingly		1SDH000649R0001
	SD030 MI	mixed inputs: 2 analogue and 2 digital	Repeats the digital inputs following a request from the master		1SDH000649R0001
	SD030 DI	8 input digital	Upon request it passes on the status of the digital inputs al master		1SDH000649R0001
	SD030 DX	Mixed inputs/outputs: 3 digital outputs and 5 digital inputs	Activates its outputs/repeats the status of its inputs following a request from the master		1SDH000649R0001
AD	AD030 DO	8 digital outputs	Receives information from MM03 and runs it digital outputs accordingly		1SDH000672R0001
	AD030 AO	4 analogue outputs	Receives information from MM03 and runs it analogue outputs accordingly		1SDH000672R0001
	AD030 MI	mixed inputs: 2 analogue and 2 digital	Repeats the digital inputs following a request from MM03		1SDH000672R0001

17. Overall dimensions

Fixed circuit-breaker

Basic version with horizontal rear terminals





Legend

① Inside edge of compartment door

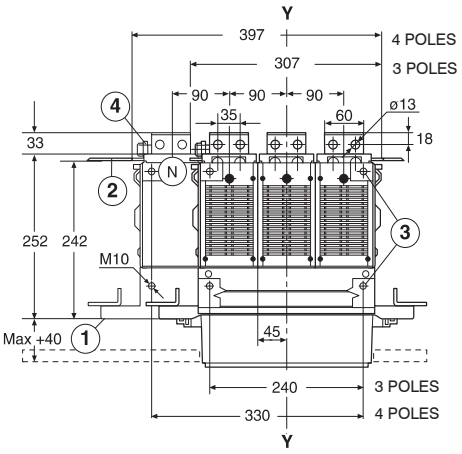
② Segregation (where foreseen)

③ Circuit-breaker M10 fixing drilling (use M10 screws)

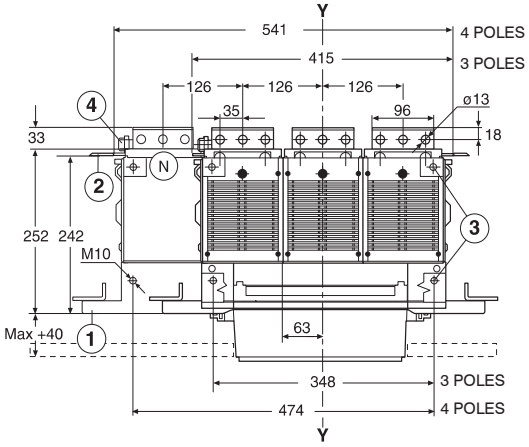
④ N° 1 M12 screw (E1, E2, E3) or n° 2 M12 screws (E4, E6) for earthing (included in the supply)

⑤ Insulating or metal-insulated wall

E1/E2
View A



E3
View A

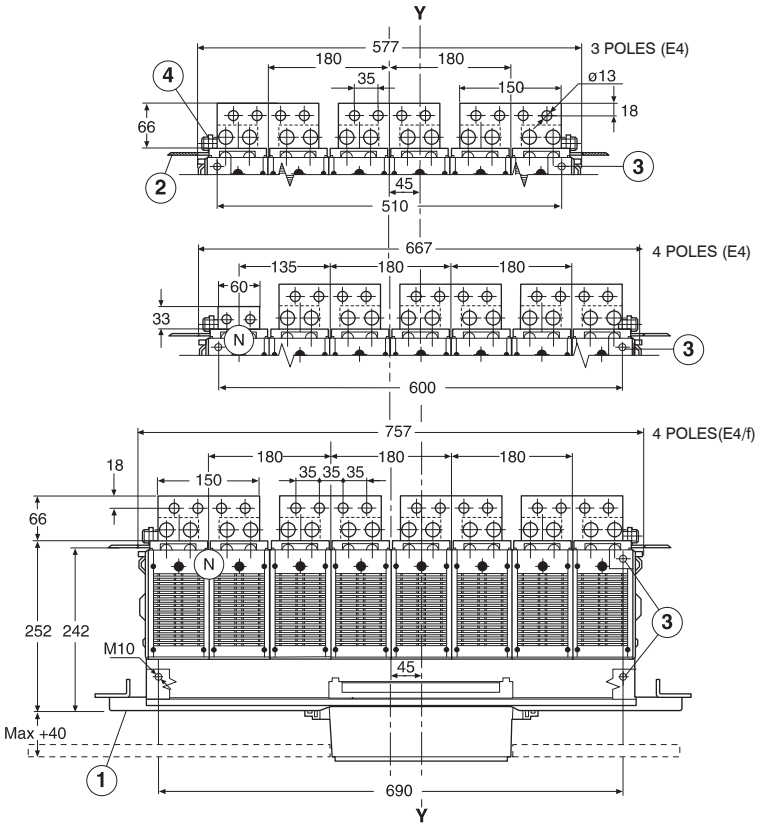


	A	B	C	D	E	F	G
E1	386	296	148	148	10	130	117,5
E2	386	296	148	148	26	114	117,5
E3	530	404	202	202	26	114	117,5
E4	656	566	238	328	26	166	91,5
E4/f	746	-	-	328	26	166	91,5
E6	908	782	328	454	26	166	91,5
E6/f	1034	-	-	454	26	166	91,5

Fixed circuit-breaker

Basic version with horizontal rear terminals

E4
View A



E6
View A

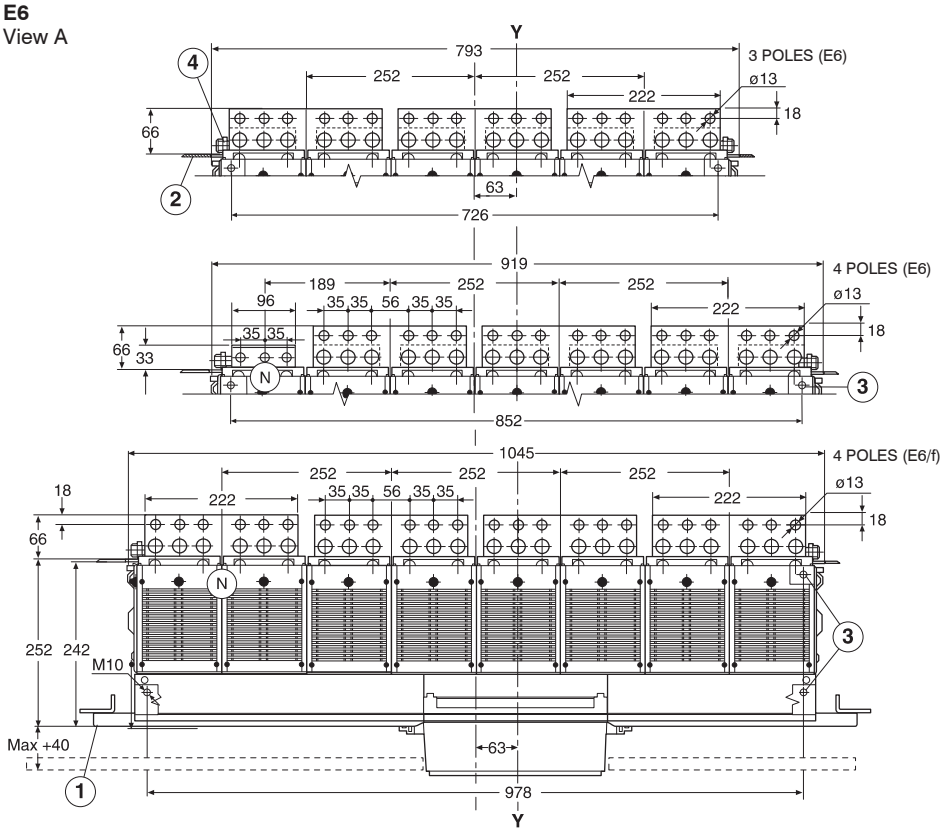
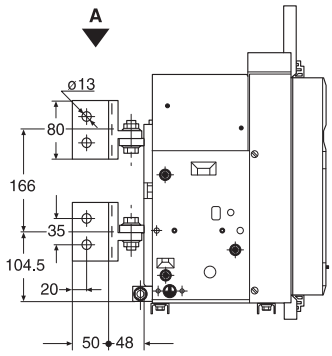


Fig. 36

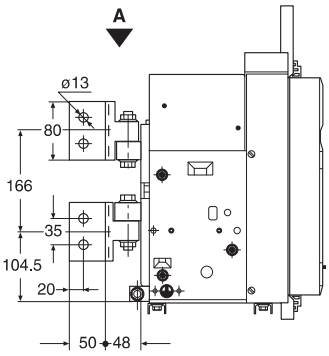
Fixed circuit-breaker

Basic version with vertical rear terminals

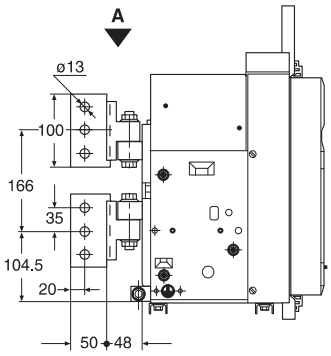
E1



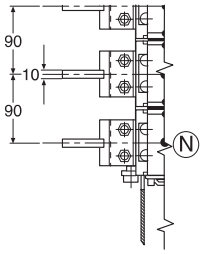
E2/E4



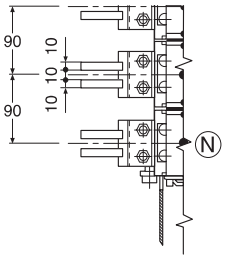
E3/E6



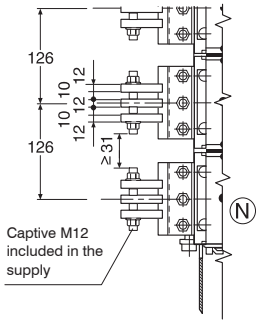
E1
View A



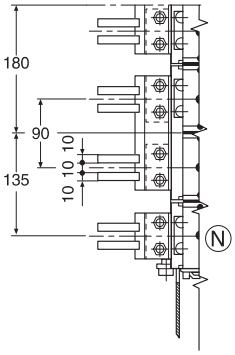
E2
View A



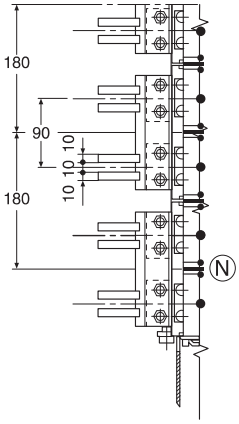
E3
View A



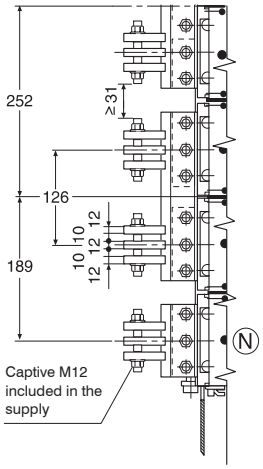
E4
View A



E4/f
View A



E6
View A



E6/f
View A

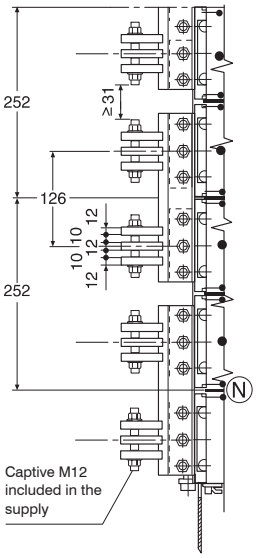
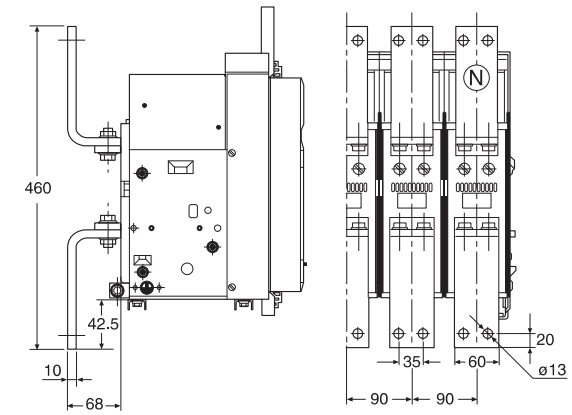


Fig. 36a

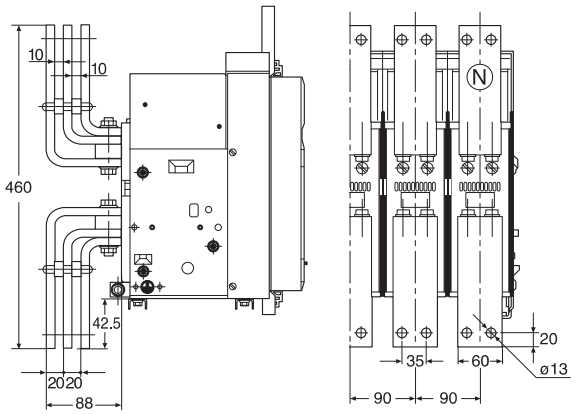
Fixed circuit-breaker

Basic version with front terminals

E1



E2



E3

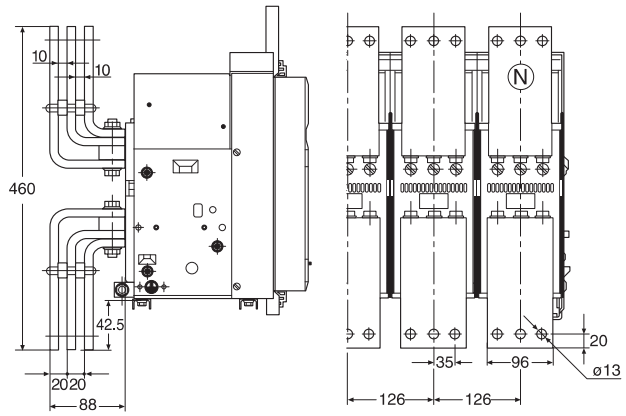
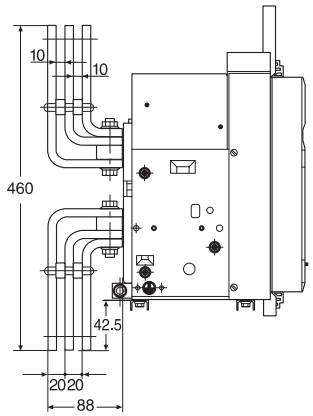


Fig. 37

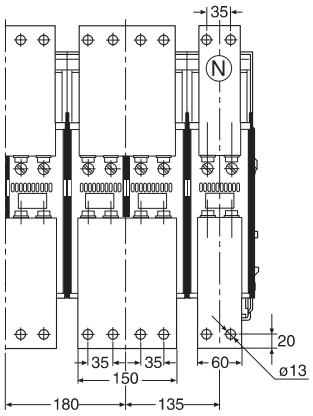
Fixed circuit-breaker

Basic version with front terminals

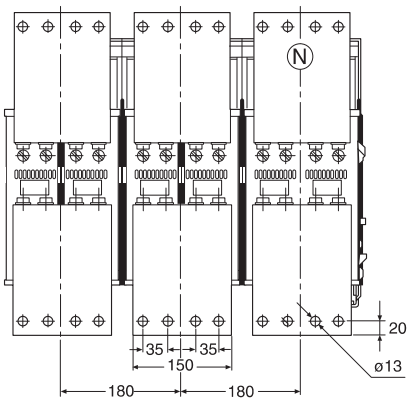
E4



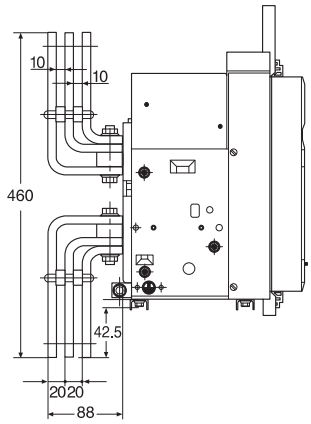
E4



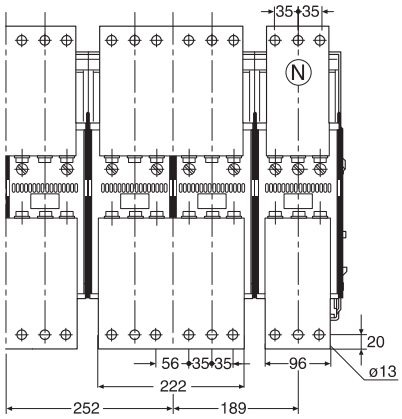
E4/f



E6



E6



E6/f

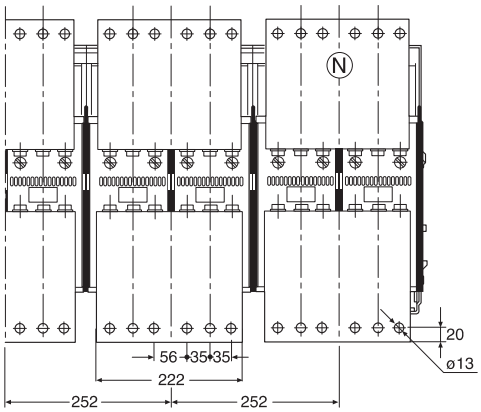
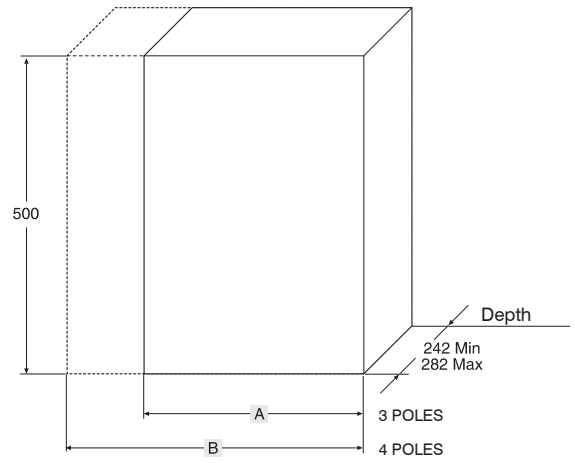
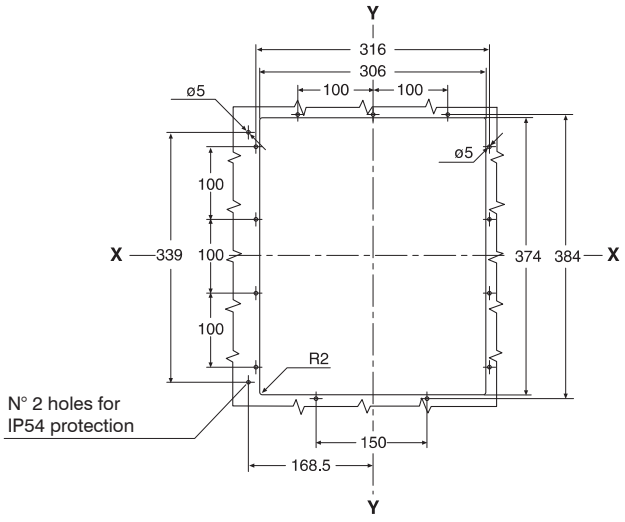


Fig. 38

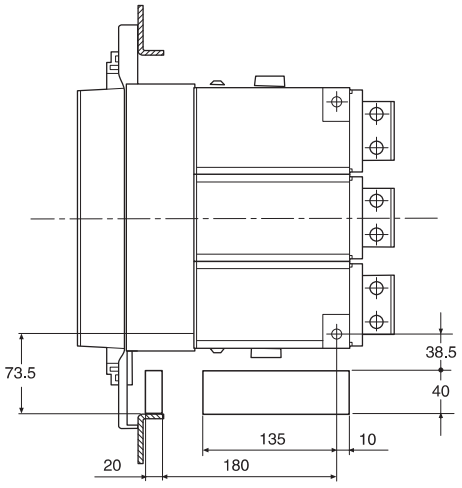
Compartment dimensions



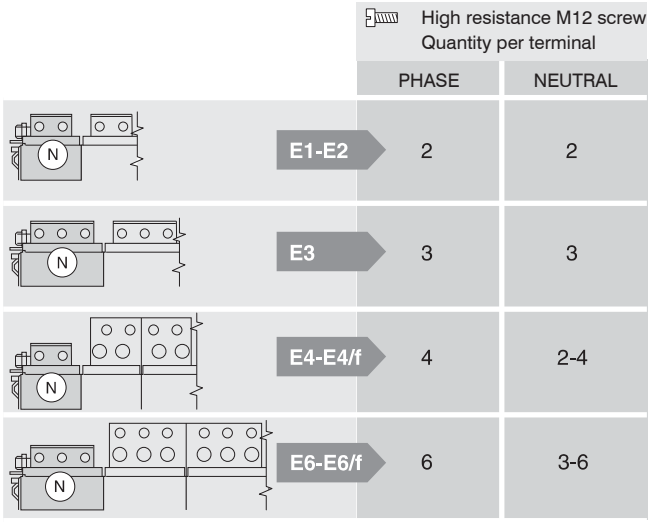
Compartment door drilling



Holes for passing through flexible cables for mechanical interlocks



Tightening torque of the main terminals: Nm 70
Tightening torque of the earthing screw: Nm 70

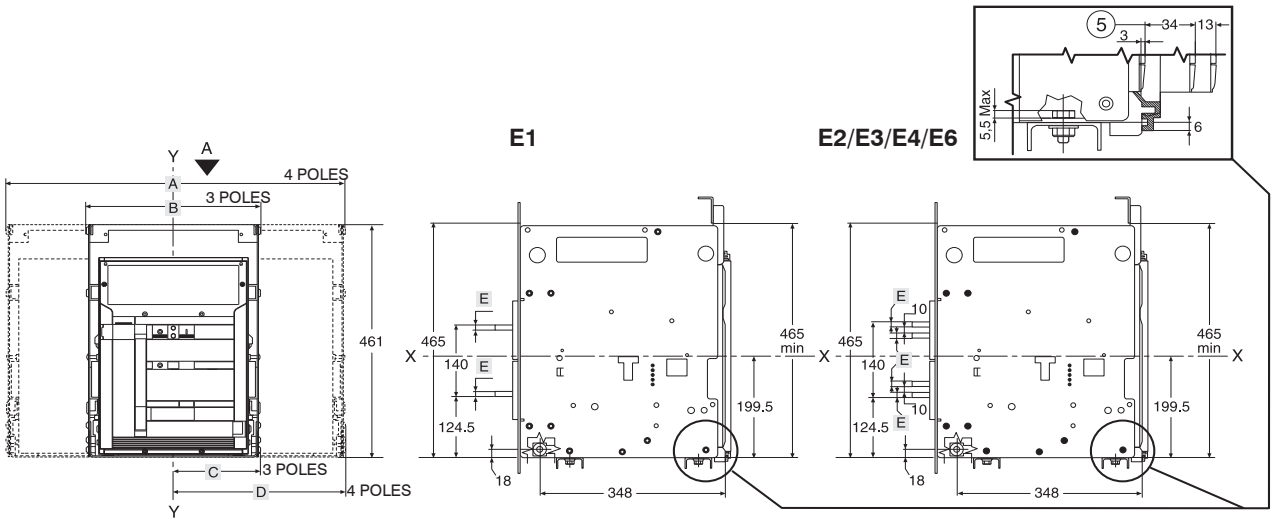


	A	B
E1	400	490
E2	400	490
E3	500	630
E4	700	790
E4/f	-	880
E6	1000	1130
E6/f	-	1260

Fig. 39

Withdrawable circuit-breaker

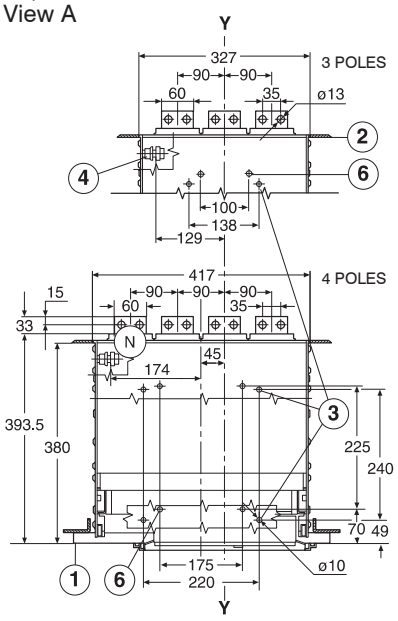
Basic version with horizontal rear terminals



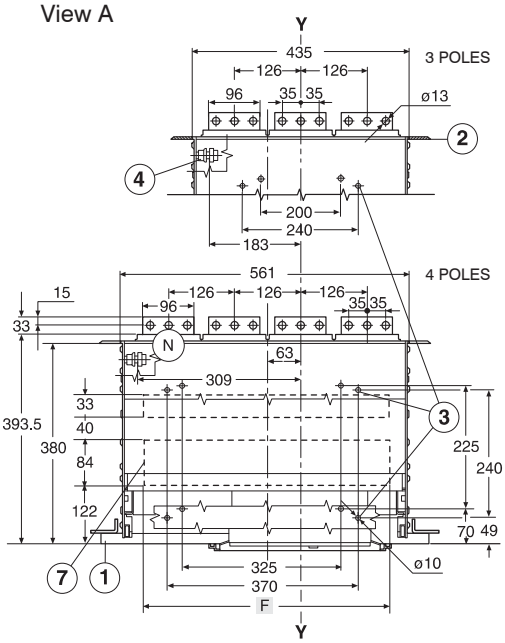
Legend

1. Inside edge of compartment door
2. Segregation (where foreseen)
3. Fixing fixed part Ø 10 drilling (use M8 screws)
4. N° 1 M12 screw (E1, E2, E3) or n° 2 M12 screws (E4, E6) for earthing (included in the supply)
5. Run from connected for a TEST to isolated
6. Alternative drilling with 25mm pitch for fixing fixed part
7. Ventilation drilling on the switchgear

E1/E2
View A



E3
View A



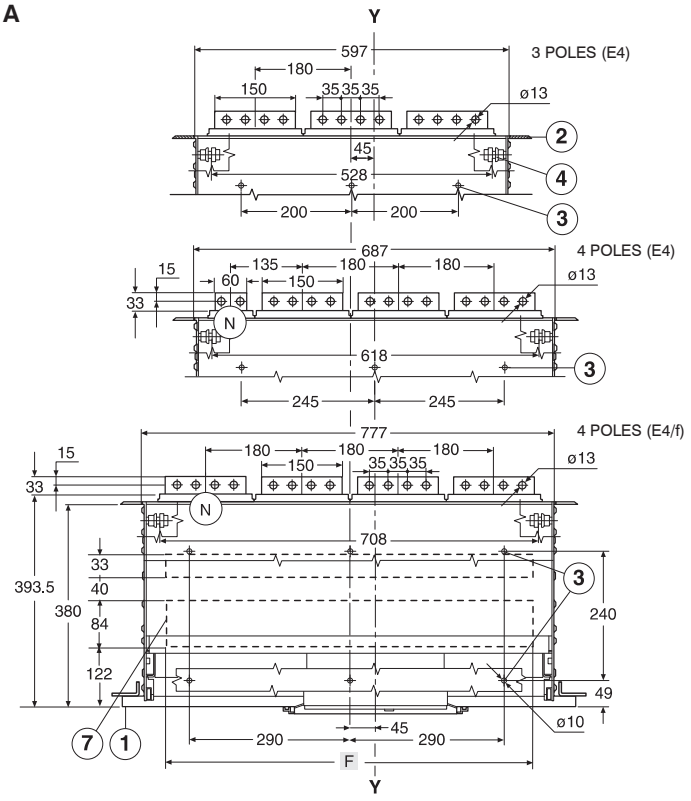
	A	B	C	D	E	F 3 poles	F 4 poles
E1	414	324	162	162	10	–	–
E2	414	324	162	162	8	–	–
E3	558	432	216	216	8	370	490
E4	684	594	252	342	8	530	610
E4/f	774	-	-	342	8	–	700
E6	936	810	342	468	8	750	870
E6/f	1062	-	-	468	8	-	1000

Fig. 40

Withdrawable circuit-breaker

Basic version with horizontal rear terminals

E4
View **A**



E6
View **A**

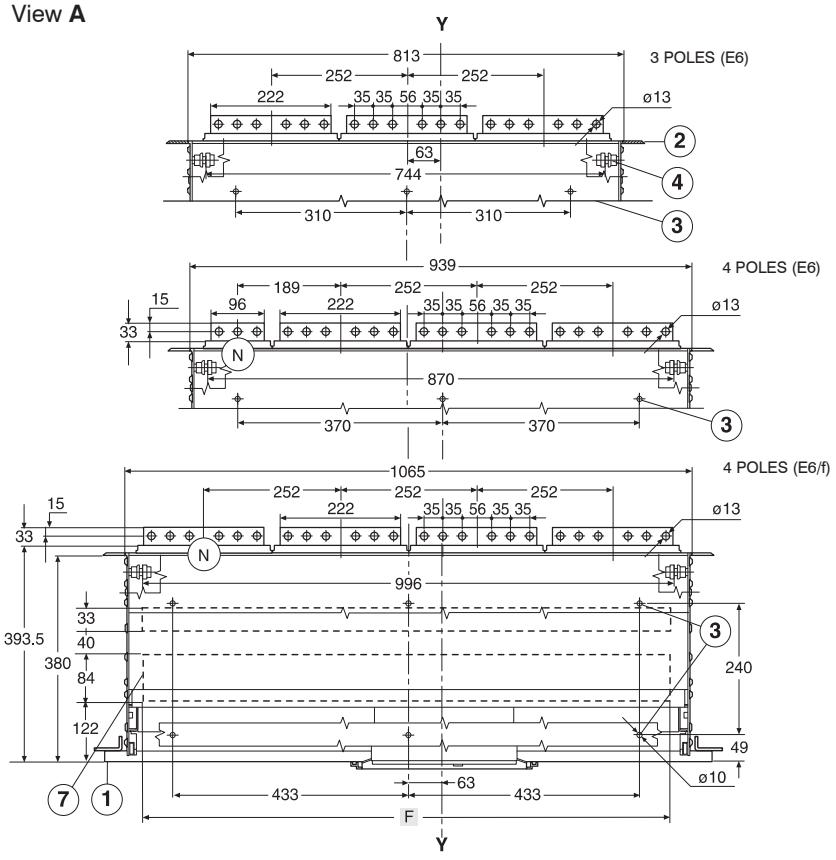


Fig. 41

Model	L2234	L4681	L5439	Apparatus	Emax	Scale
	L2778	L5179				
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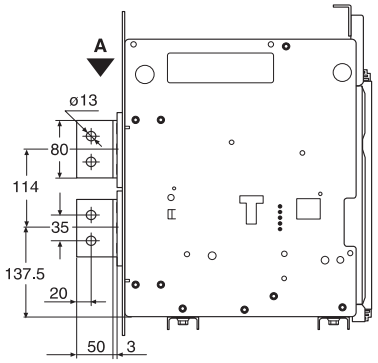
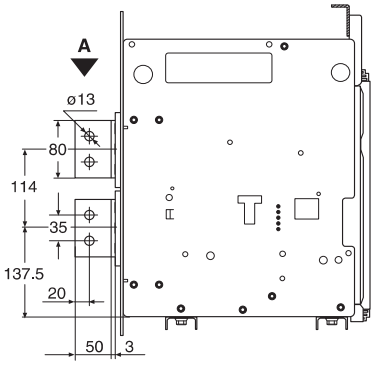
Withdrawable circuit-breaker

Basic version with vertical rear terminals

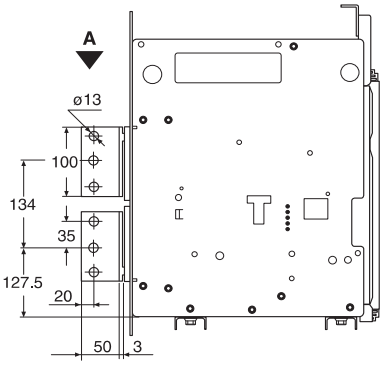
E1



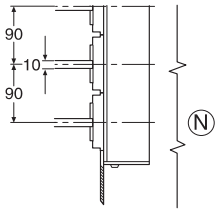
E2/E4



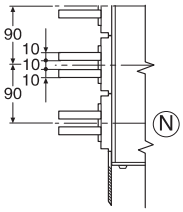
E3/E6



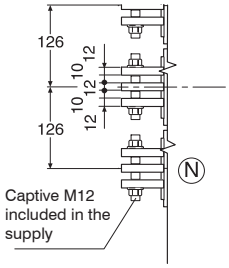
E1
View A



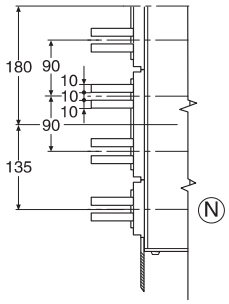
E2
View A



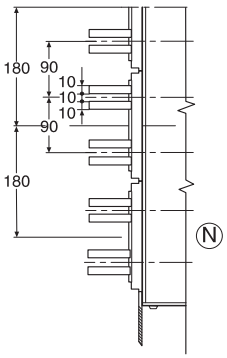
E3
View A



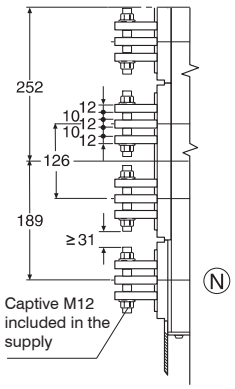
E4
View A



E4/f
View A



E6
View A



E6/f
View A

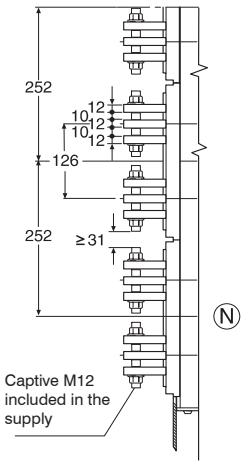
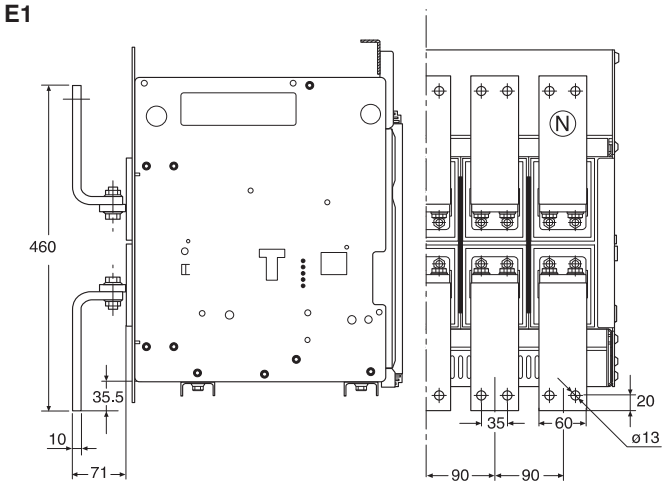


Fig. 42

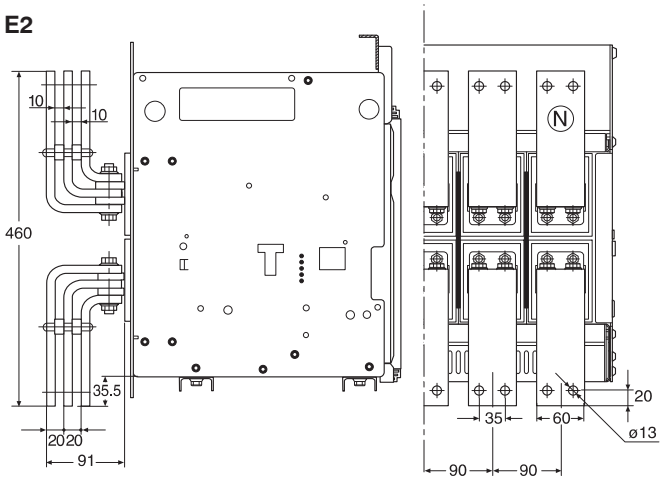
Withdrawable circuit-breaker

Version with front terminals

E1



E2



E3

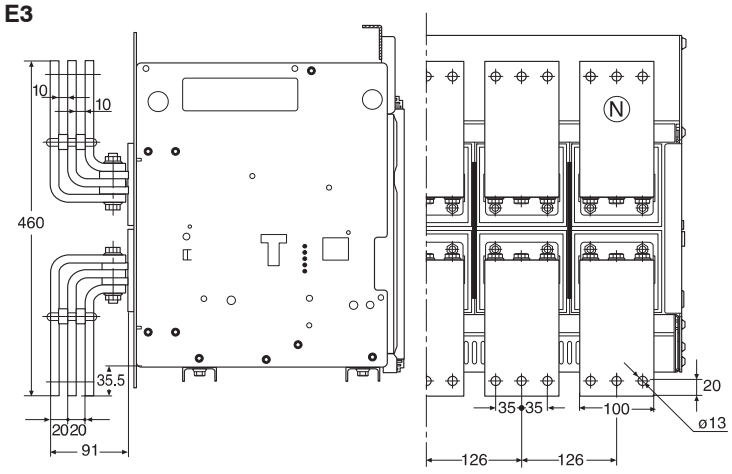
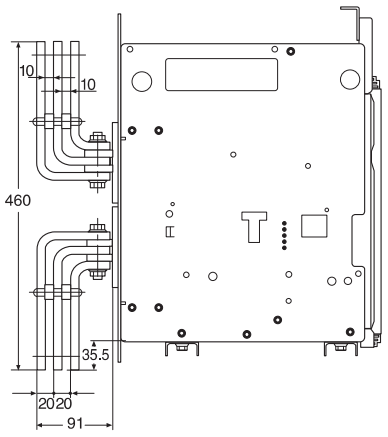


Fig. 43

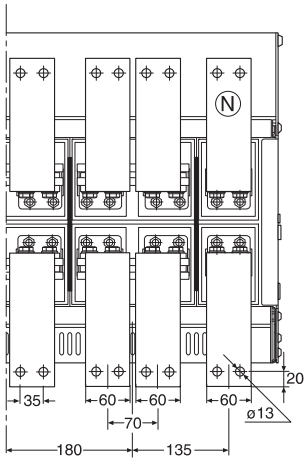
Withdrawable circuit-breaker

Version with front terminals

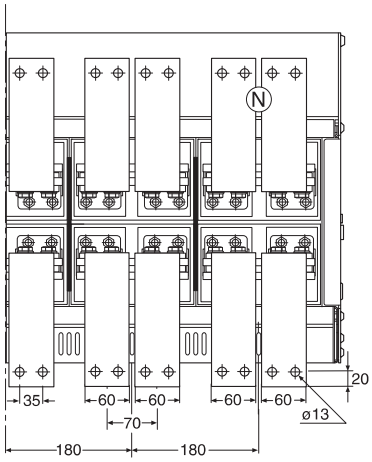
E4



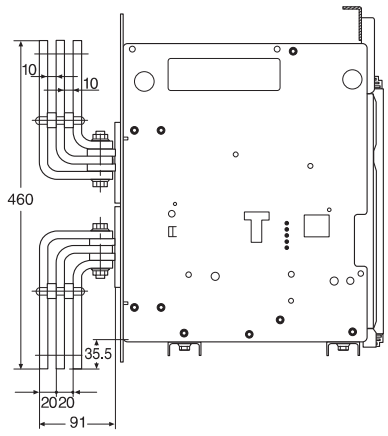
E4



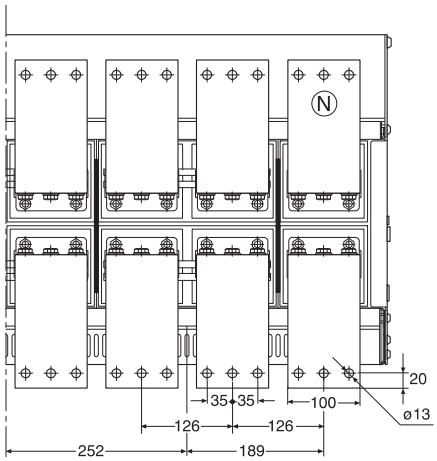
E4/f



E6



E6



E6/f

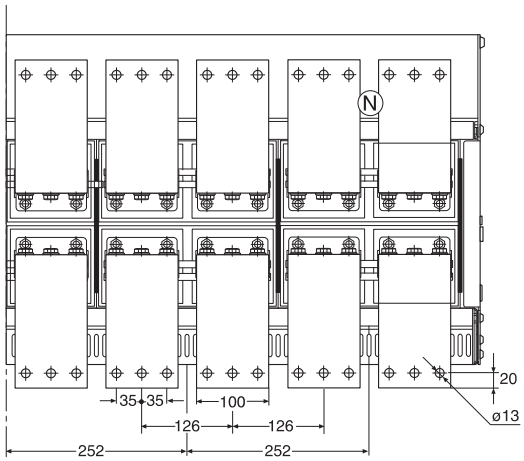
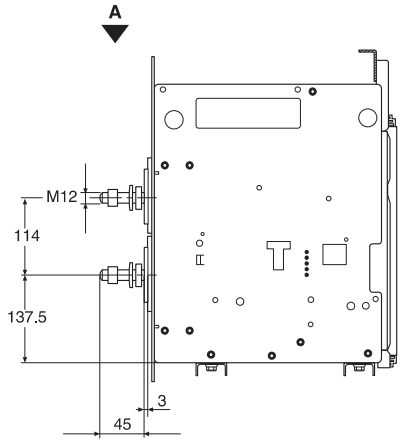


Fig. 44

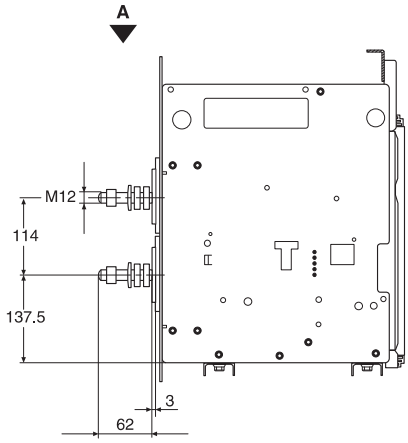
Withdrawable circuit-breaker

Version with flat terminals

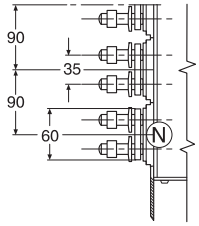
E1



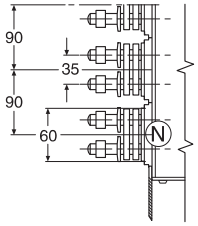
E2



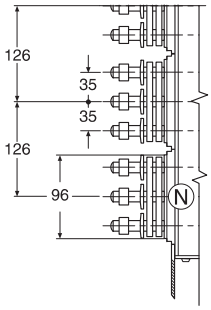
E1
View A



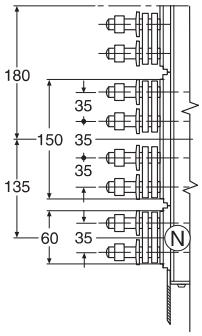
E2
View A



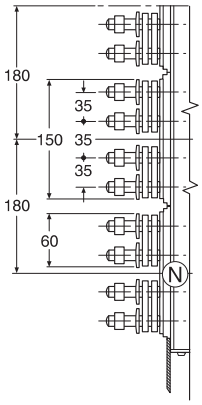
E3
View A



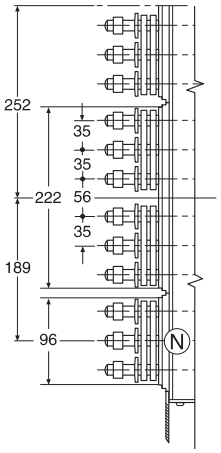
E4
View A



E4/f
View A



E6
View A



E6/f
View A

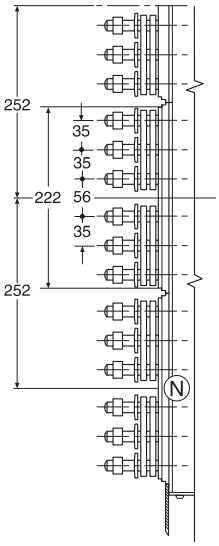


Fig. 45

Model	L2234	L4681	L5439	Apparatus	Emax	Scale
	L2778	L5179				
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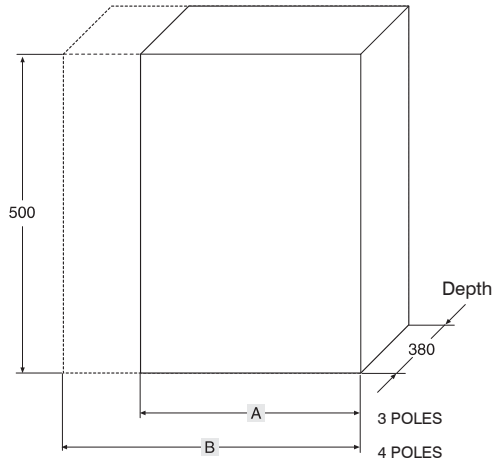
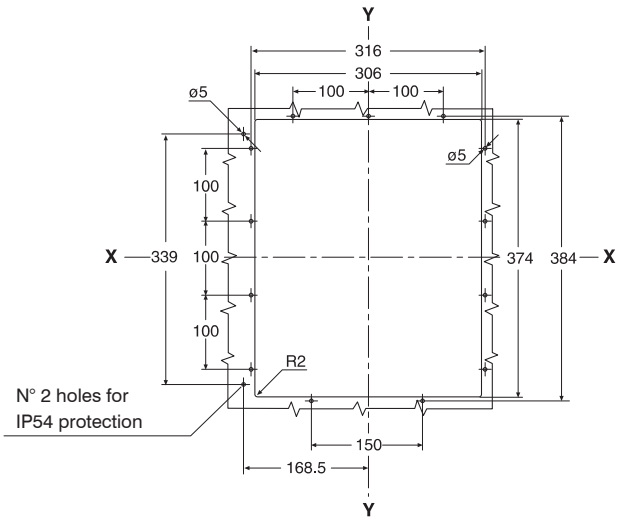
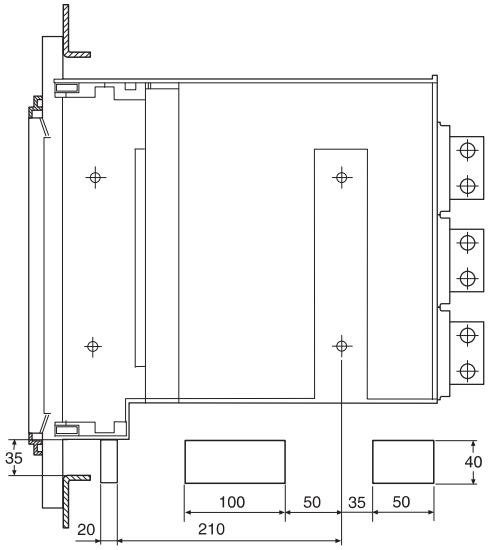
Compartment dimensions



Compartment door drilling



Holes for passing through flexible cables for mechanical interlocks



	A	B
E1	400	490
E2	400	490
E3	500	630
E4	700	790
E4/f	-	880
E6	1000	1130
E6/f	-	1260

Tightening torque of the fixing screws: 20 Nm
Tightening torque of the main terminals: 70 Nm
Tightening torque of the earthing screw: 70 Nm

	High resistance M12 screw Quanty per terminal	
	PHASE	NEUTRAL
E1-E2	2	2
E3	3	3
E4-E4/f	4	2-4
E6-E6/f	6	3-6

Fig. 46

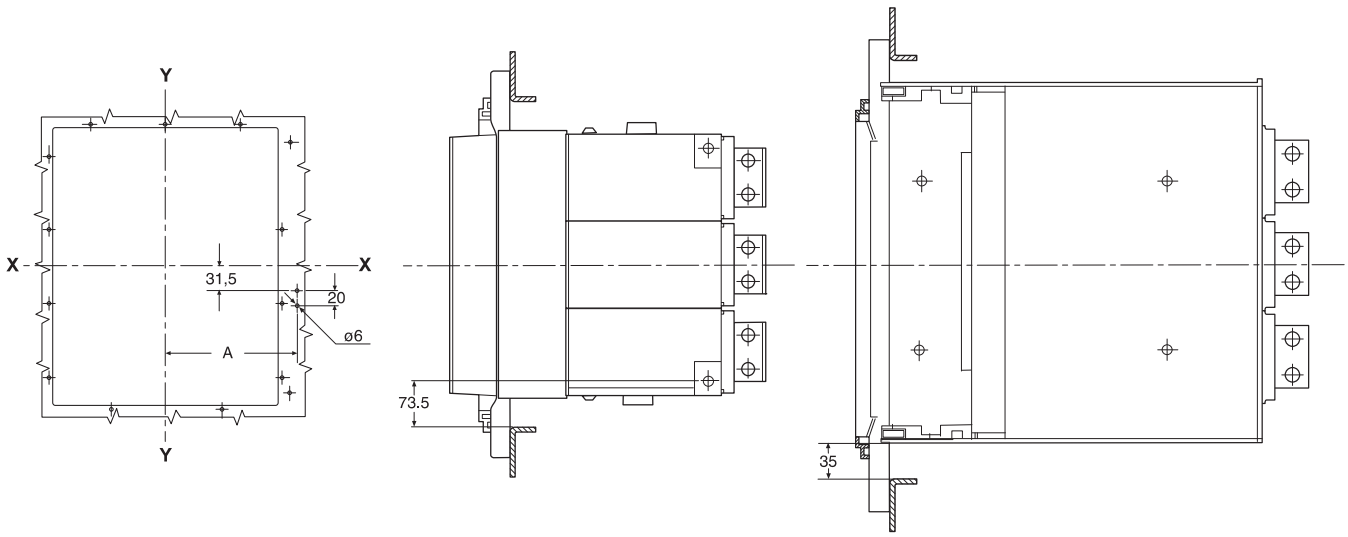
Compartment door mechanical lock

Door drilling

Minimum distance between the circuit-breaker and the switchgear wall

Fixed version

Withdrawable version



	A 3 POLES	A 4 POLES
E1	180	180
E2	180	180
E3	234	234
E4	270	360
E4/f	-	360
E6	360	486
E6/f	-	486

Fig. 47

18. Circuit diagrams

WARNING:
Before installing the circuit-breaker, carefully read notes F and O on the circuit diagrams.

Operating status shown

The circuit diagram is for the following conditions:
- withdrawable circuit-breaker, open and racked-in
- circuits de-energised
- releases not tripped
- motor operating mechanism with springs unloaded.

Versions

The diagram shows a circuit-breaker in withdrawable version; it can be applied to a fixed version circuit-breaker as well.

Fixed version
The control circuits are fitted between terminals XV (connector X is not supplied).
With this version, the applications indicated in figures 31 and 32 cannot be provided.

Withdrawable version
The control circuits are fitted between the poles of connector X (terminal box XV is not supplied).

Version without overcurrent release
With this version, the applications indicated in figures 13, 14, 41, 42, 43, 44, 45, 46, 47, 48, 62 cannot be provided.

Version with PR121/P electronic release
With this version, the applications indicated in figures 42, 43, 44, 45, 46, 47, 48 cannot be provided.

Version with PR122/P electronic release
With this version, the applications indicated in figure 41 cannot be provided.

Version with PR123/P electronic release
With this version, the applications indicated in figure 41 cannot be provided.

18.1. Caption

□ = Circuit diagram figure number
* = See note indicated by the letter
A1 = Circuit-breaker accessories
A3 = Accessories applied to the fixed part of the circuit-breaker (for withdrawable version only)
A4 = Example switchgear and connections for control and signalling, outside the circuit-breaker
A13 = PR021/K signalling unit (outside the circuit-breaker)
AY = SACE SOR TEST UNIT Test/monitoring Unit (see note R)
D = Electronic time-delay device of the undervoltage release, outside the circuit-breaker
F1 = Delayed-trip fuse
K51 = PR121/P, PR122/P, PR123/P electronic release with the following protection functions:
- L overload protection with inverse long time-delay trip-setting I1
- S short-circuit protection with inverse or definite short time-delay trip-setting I2
- I short-circuit protection with instantaneous time-delay trip-setting I3
- G earth fault protection with inverse short time-delay trip-setting I4

K51/1...8 = Contacts for the PR021/K signalling unit
K51/GZin(DBin)= Zone selectivity: for protection G (only with Vaux and PR122/P or PR123/P release) or “reverse” direction input for protection D (only with Vaux and PR123/P release)
K51/GZout(DBout) = Zone selectivity: for protection G (only with Vaux and PR122/P or PR123/P release) or “reverse” direction output for protection D (only with Vaux and PR123/P release)
K51/IN1 = Digital programmable input (available only with Vaux and release PR122/P or PR123/P with indicator module PR120/K)
K51/P1...P4 = Programmable electrical signalling (available only with Vaux and release PR122/P or PR123/P with indicator module PR120/K)
K51/SZin(Dfin) = Zone selectivity: input for protection S or “direct” input for protection D (only with Vaux and PR122/P or PR123/P release)
K51/SZout(DFout) = Zone selectivity: output for protection S or “direct” output for protection D (only with Vaux and PR122/P or PR123/P release)
K51/YC = Closing control from PR122/P or PR123/P electronic release with communication module PR120/D-M
K51/YO = Opening control from PR122/P or PR123/P electronic release with communication module PR120/D-M
M = Motor for loading the closing springs
Q = Circuit-breaker
Q/1...27 = Circuit-breaker auxiliary contacts
S33M/1...3 = Limit contacts for spring-loading motor
S43 = Switch for setting remote/local control
S51 = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release. The circuit-breaker may be closed only after pressing the reset pushbutton, or after energizing the coil for electrical reset (if available)

S75E/1.4 = Contacts for electrical signalling of circuit-breaker in disconnected position (only with withdrawable circuit-breakers)
S75I/1..5 = Contacts for electrical signalling of circuit-breaker in connected position (only with withdrawable circuit-breakers)
S75T/1..4 = Contacts for electrical signalling of circuit-breaker in test isolated position (only with withdrawable circuit-breakers)
SC = Pushbutton or contact for closing the circuit-breaker
SO = Pushbutton or contact for opening the circuit-breaker
SO1 = Pushbutton or contact for opening the circuit-breaker with delayed trip
SO2 = Pushbutton or contact for opening the circuit-breaker with instantaneous trip
SR = Pushbutton or contact for electrical circuit-breaker reset
TI/L1 = Current transformer located on phase L1
TI/L2 = Current transformer located on phase L2
TI/L3 = Current transformer located on phase L3
TO = Homopolar toroidal current transformer (see note W)
Vaux = Auxiliary power supply voltage (see note F)
UI/L1 = Current sensor (Rogowski coil) located on phase L1
UI/L2 = Current sensor (Rogowski coil) located on phase L2
UI/L3 = Current sensor (Rogowski coil) located on phase L3
UI/N = Current sensor (Rogowski coil) located on neutral
UI/0 = Current sensor (Rogowski coil) located on the conductor connecting to earth the star point of the MV/LV transformer (see note G)
W1 = Serial interface with control system (external bus): EIA RS485 interface (see note E)
W2 = Serial interface with the accessories of PR121/P, PR122/P and PR123/P releases (internal bus)
X = Delivery connector for auxiliary circuits of withdrawable version circuit-breaker
X1...X7 = Connectors for the accessories of the circuit-breaker
XF = Delivery terminal box for the position contacts of the withdrawable circuit-breaker (located on the fixed part of the circuit-breaker)
XK1 = Connector for power circuits of PR121/P, PR122/P and PR123/P releases
XK2 - XK3 = Connectors for auxiliary circuits of PR121/P, PR122/P and PR123/P releases
XK4 = Connector to signal open/close
XK5 = PR120/V module connector
XO = Connector for YO1
XV = Delivery terminal box for the auxiliary circuits of the fixed circuit-breaker
YC = Shunt closing release
YO = Shunt opening release
YO2 = Second shunt opening release (see note Q)
YR = Coil to electrically reset the circuit-breaker
YU = Undervoltage release (see notes B and Q)

18.2. Description of figures

Fig. 1 = Motor circuit to load the closing springs.
Fig. 2 = Circuit of shunt closing release.
Fig. 4 = Shunt opening release.
Fig. 6 = Instantaneous undervoltage release (see notes B and Q).
Fig. 7 = Undervoltage release with electronic time-delay device, outside the circuit-breaker (see notes B and Q)
Fig. 8 = Second shunt opening release (see note Q).
Fig.11 = Contact for electrical signalling of springs loaded.
Fig.12 = Contact for electrical signalling of undervoltage release energized (see notes B and S).
Fig.13 = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release. The circuit-breaker may be closed only after pressing the reset pushbutton.
Fig.14 = Contact for electrical signalling of circuit-breaker open due to tripping of the overcurrent release and electrical reset coil. The circuit-breaker may be closed only after pressing the reset pushbutton or energizing the coil.
Fig.21 = First set of circuit-breaker auxiliary contacts.
Fig.22 = Second set of circuit-breaker auxiliary contacts (not available for PR122/P and PR123/P releases)(see note V)
Fig.23 = Third set of supplementary auxiliary contacts outside the circuit-breaker.
Fig.31 = First set of contacts for electrical signalling of circuit-breaker in connected, test isolated, disconnected position.
Fig. 32 = Second set of contacts for electrical signalling of circuit-breaker in connected, test isolated, disconnected position.
Fig.41 = Auxiliary circuits of PR121/P release (see note F).
Fig.42 = Auxiliary circuits of PR122/P and PR123/P releases (see notes F, M and V).
Fig.43 = Circuits of the measuring module PR120/V of the PR122/P and PR123/P releases internally connected to the three-pole and four-pole circuit-breaker (optional for the release PR122/P) (see note U).
Fig.44 = Circuits of the measuring module PR120/V of the PR122/P and PR123/P releases externally connected to the circuit-breaker (optional for the release PR122/P) (see note O, U and X).
Fig.45 = Circuits of the communication module PR120/D-M of the PR122/P and PR123/P releases (optional) (see note E).
Fig.46 = Circuits of the indicator module PR120/K of the PR122/P and PR123/P releases - connection 1 (optional) (see note V).

Fig.47 = Circuits of the indicator module PR120/K of the PR122/P and PR123/P releases - connection 2 (optional) (see note V).
Fig.48 = Circuits of the measuring module PR120/V of the PR122/P and PR123/P releases connected inside the three-pole circuit-breaker with outside neutral conductor (optional for the release PR122/P)(see note U).
Fig.61 = SACE SOR TEST UNIT Test/monitoring Unit (see note R)
Fig.62 = Circuits of the signalling unit PR021/K (outside the circuit-breaker).

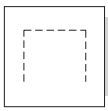
18.3. Incompatibilities

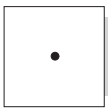
The circuits indicated in the following figures cannot be supplied simultaneously on the same circuit-breaker:
6 - 7 - 8
13 - 14
22 - 46 - 47
43 - 44 - 48

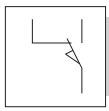
18.4. Notes

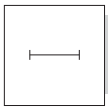
A) The circuit-breaker is only fitted with the accessories specified in the ABB SACE order acknowledgement. Consult this catalogue for information on how to make out an order.
B) The undervoltage release is supplied for operation using a power supply branched on the supply side of the circuit-breaker or from an independent source. The circuit-breaker can only close when the release is energized (there is a mechanical lock on closing).
If the same power supply is used for the closing and undervoltage releases and the circuit-breaker is required to close automatically when the auxiliary power supply comes back on, a 30 ms delay must be introduced between the undervoltage release accept signal and the energizing of the closing release. This may be achieved using an external circuit comprising a permanent make contact, the contact shown in fig. 12 and a time-delay relay.
E) For connecting the EIA RS485 serial line, see “Technical Application Book – volume 9” communication via BUS with the ABB switches.
F) The auxiliary voltage Vaux allows actuation of all operations of the PR121/P, PR122/P and PR123/P releases.
Having requested a Vaux insulated from earth, one must use “galvanically separated converters” in compliance with IEC 60950 (UL 1950) or equivalent standards that ensure a common mode current or leakage current (see IEC 478/1, CEI 22/3) not greater than 3.5 mA, IEC 60364-41 and CEI 64-8.
G) Earth fault protection is available with the PR122/P and PR123/P releases by means of a current sensor located on the conductor connecting to earth the star center of the MV/LV transformer.
The connections between terminals 1 and 2 (or 3) of current transformer UI/O and poles T7 and T8 of the X (or XV) connector must be made with a two-pole shielded and stranded cable (type BELDEN 3105A/3105B) no more than 15m long. The shield must be earthed on the circuit-breaker side and current sensor side.
N) With releases PR122/P and PR123/P, the connections to the zone selectivity inputs and outputs must be made with a two-pole shielded and stranded cable (type BELDEN 3105A/3105B), no more than 300m long. The shield must be earthed on the selectivity input side.
O) Systems with a rated voltage greater than 690V require the use of an insulation voltage transformer to connect to the busbars (connect according to the diagrams on the sheet provided with the kit 1SDH000460R0508).
P) With releases PR122/P and PR123/P with communication module PR120/D-M, the coils YO and YC are controlled directly from contacts K51/YO and K51/YC with maximum voltages of 110-120 VDC and 240-250 VAC.
Q) The second shunt opening release may be installed as an alternative to the undervoltage release.
R) The SACE SOR TEST UNIT + opening release (YO) is guaranteed to operate starting at 75% of the Vaux of the opening release itself.
While the YO power supply contact is closing (short-circuit on terminals 4 and 5), the SACE SOR TEST UNIT is unable to detect the opening coil status.
Consequently:
- For continuously powered opening coil, the TEST FAILED and ALARM signals will be activated
- If the coil opening command is of the pulsing type, the TEST FAILED signal may appear at the same time. In this case, the TEST FAILED signal is actually an alarm signal only if it remains lit for more than 20s.
S) Also available in the version with normally-closed contact
U) The measuring module PR120/V is always supplied with relay PR123/P.
V) If fig. 22 is present (second set of auxiliary contacts) simultaneously as relay PR122/P (or PR123/P), the contacts for the zone selectivity in fig. 42 (K51/SZin, K51/SZout, K51/GZin and K51/GZout) are not wired. In addition, the indicator module PR120/K in figures 46 and 47 cannot be supplied.
W) For the connections between TO toroidal transformer and poles of CB X (or XV) connector, use a shielded 4-pole cable with paired braided wires (BELDEN 9696 paired type), length not exceeding 10m. The shielding will be grounded on CB side.
X) T3 and T4 poles of X (or XV) connector are used to measure voltage when U>690V. In this case, they must be connected to the secondary winding of the TU voltage transformer (see fig. 44). Ask ABB SACE for applications of the residual current protection with voltages higher than 690V.
Y) The shielding of the connection cable will be grounded on CB side only. The connection must be made with a two-pole shielded and stranded cable (type BELDEN 3105A) no more than 15m long.
Z) Short-circuit T5 and T6 if the external neutral current sensor (UI/N)is not connected.

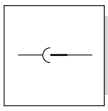
Circuit diagram symbols (IEC 60617 and CEI 3-14 ... 3-26 Standards)

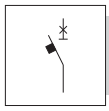

Shield
(may be drawn
in any shape)

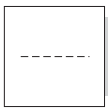

Terminal

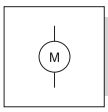

Change-over position contact with momentary circuit breaking (limit contact)


Time delay

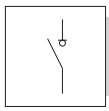

Plug and socket
(male and female)

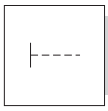

Power isolator with automatic breaking action

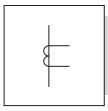

Mechanical or electrical connection

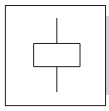


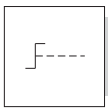
Motor
(general symbol)

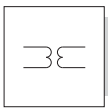

Switch-disconnector

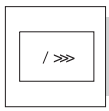

Manual mechanical control (general case)

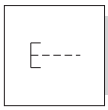

Current transformer

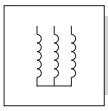

Control coil
(general symbol)

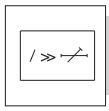

Rotating control

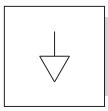

Voltage transformer

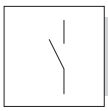

Instantaneous overcurrent relay

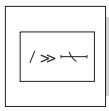

Pushbutton control

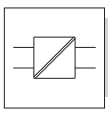

Winding of three-phase transformer, Star connection

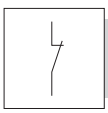

Overcurrent relay with adjustable short time-delay trip

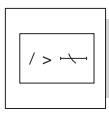

Equipotentiality


Make contact

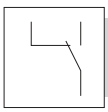

Overcurrent relay with inverse short time-delay tripa tempo breve inverso

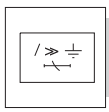

Galvanically separated converter


Break contact with automatic circuit breaking

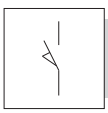

Overcurrent relay with inverse long time-delay trip

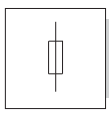

Shielded cable conductors (i.e., 3 conductors shown)

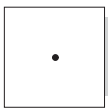

Change-over contact

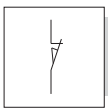

Earth fault overcurrent relay with inverse short time delay

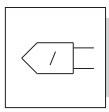

Conductors or stranded cables (i.e., 3 conductors shown)


Make position contact (limit contact)


Fuse (general symbol)

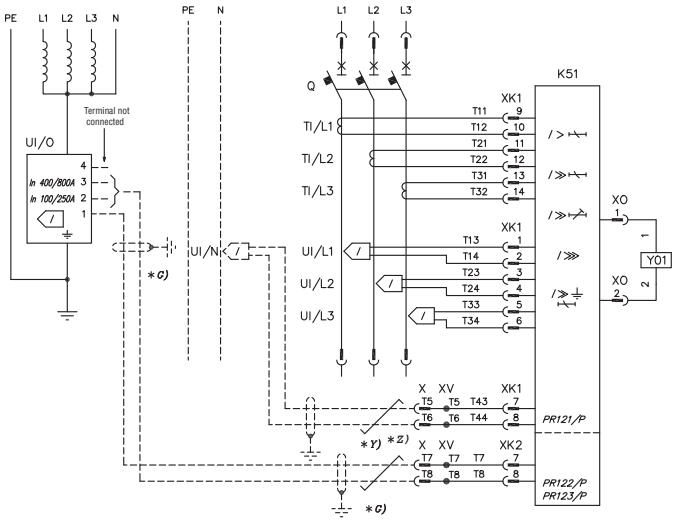

Connection of conductors


Break position contact (limit contact)

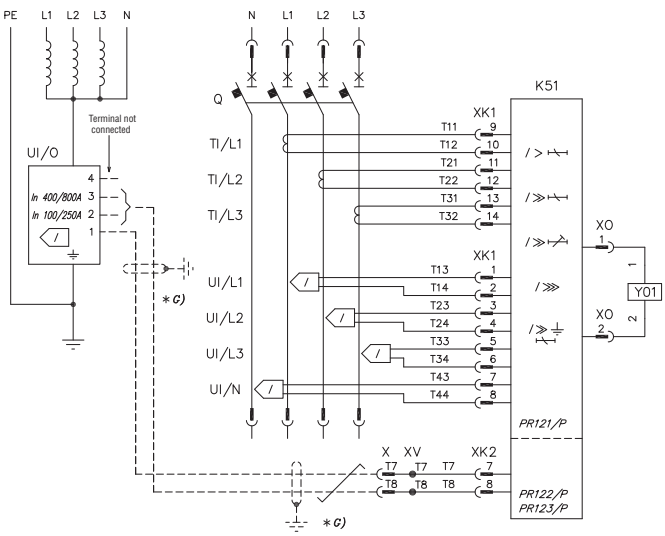

Current sensor

Circuit diagram - Operating status

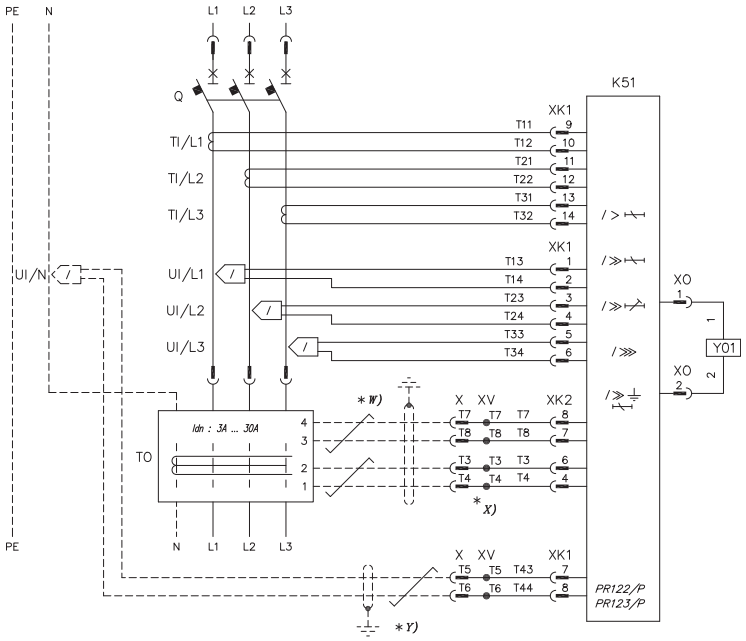
Three-pole circuit-breaker with PR121/P, PR122/P or PR123/P electronic release



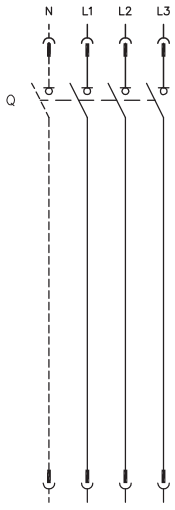
Four-pole circuit-breaker with PR121/P, PR122/P or PR123/P electronic release



Three-pole circuit-breaker with PR122/P or PR123/P electronic release, residual current protection and U<=690V.

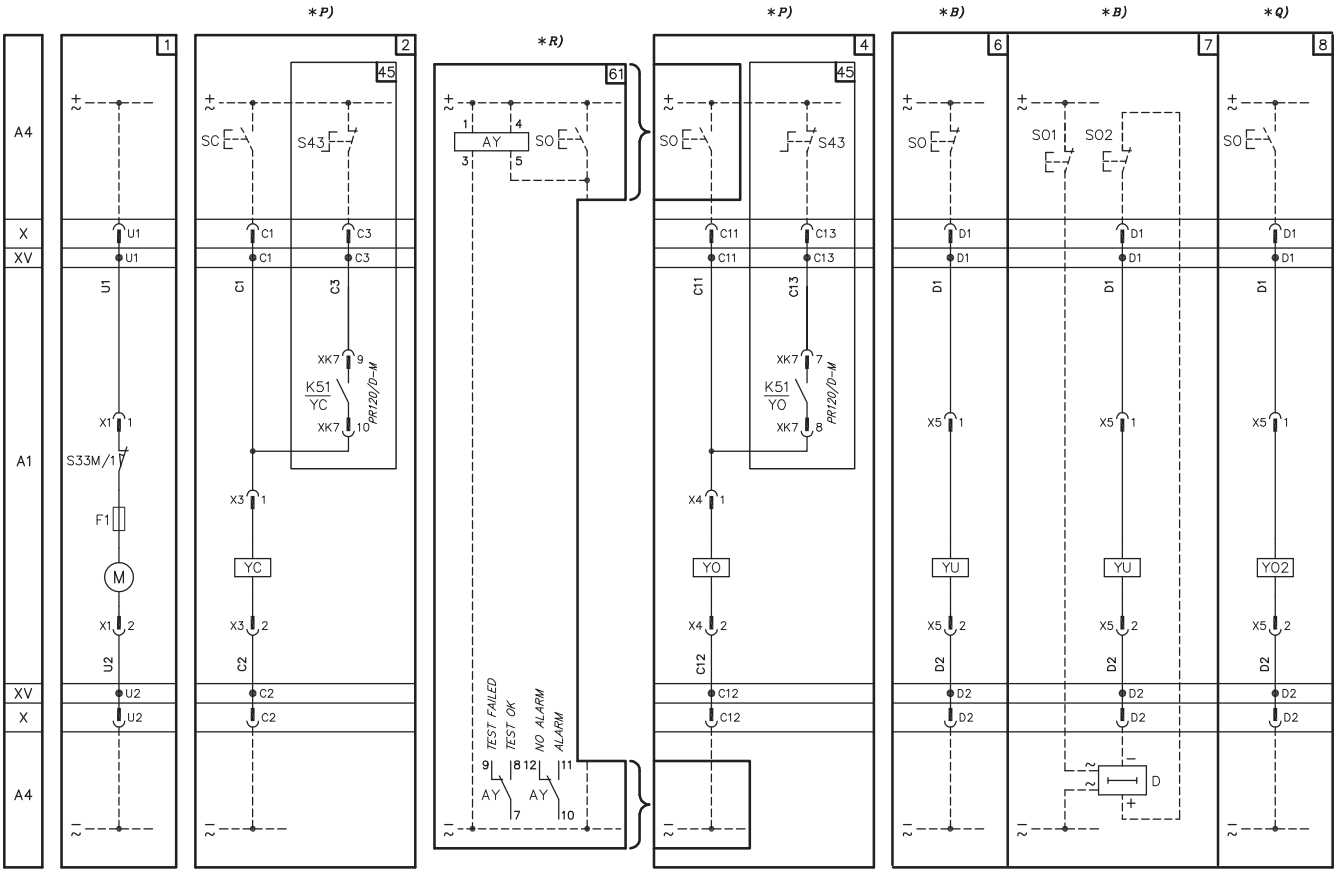


Three-or four-pole switch-disconnector

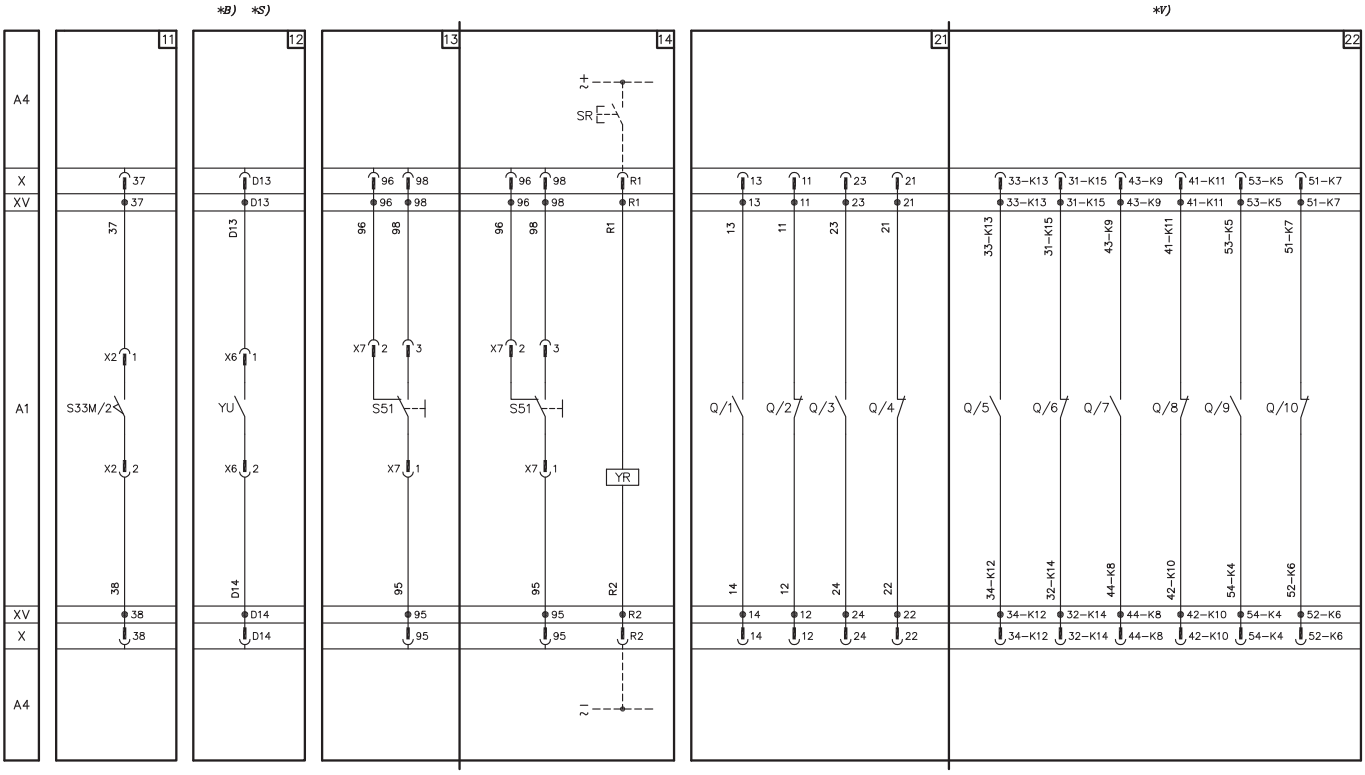


Model	L2234	L4681	L5439	Apparatus	**Emax**	Scale
	L2778	L5179				
				Doc. no.	**1SDH000460R0002**	Page No **156/161**

Motor operating mechanism, opening, closing and undervoltage releases

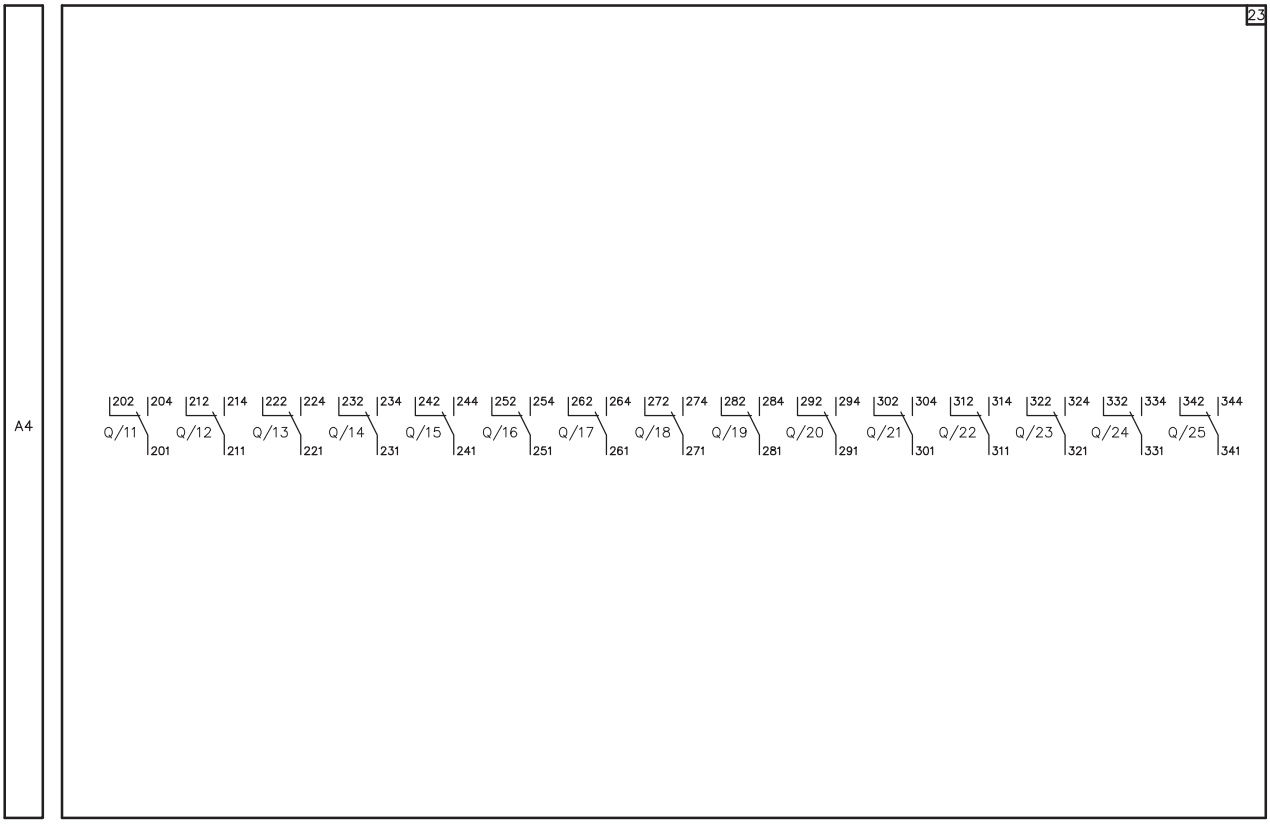


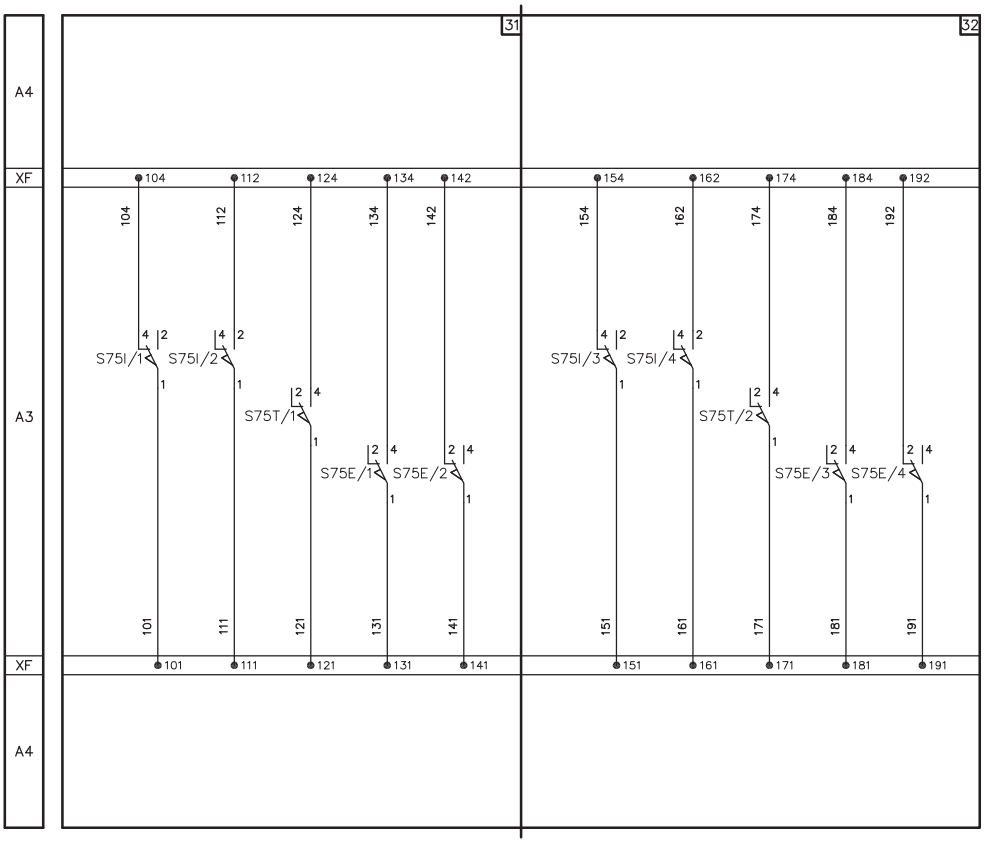
Signalling contacts



Model	L2234	L4681	L5439	Apparatus	Emax	Scale
	L2778	L5179				
				Doc. No	1SDH000460R0002	Page No 157/161

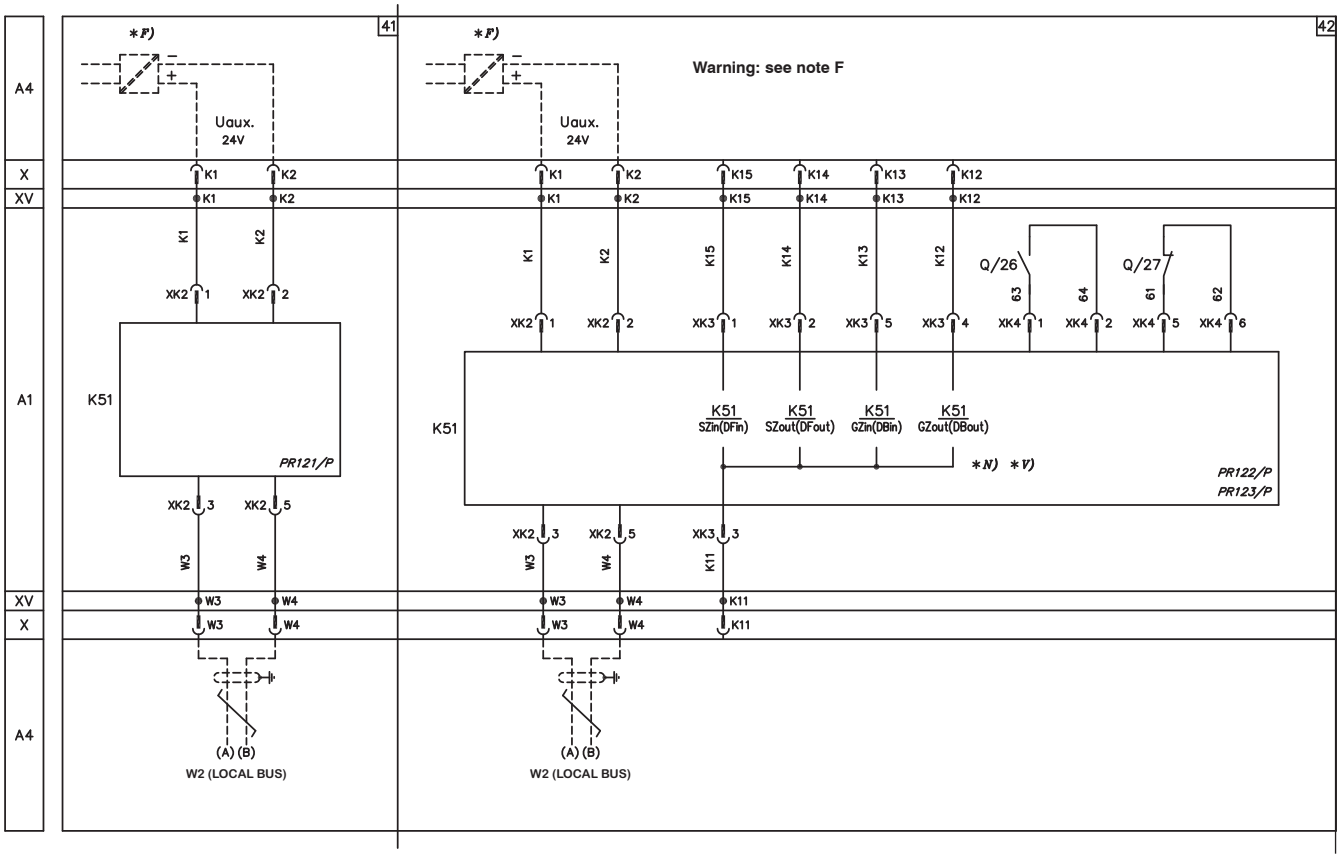
Signalling contacts



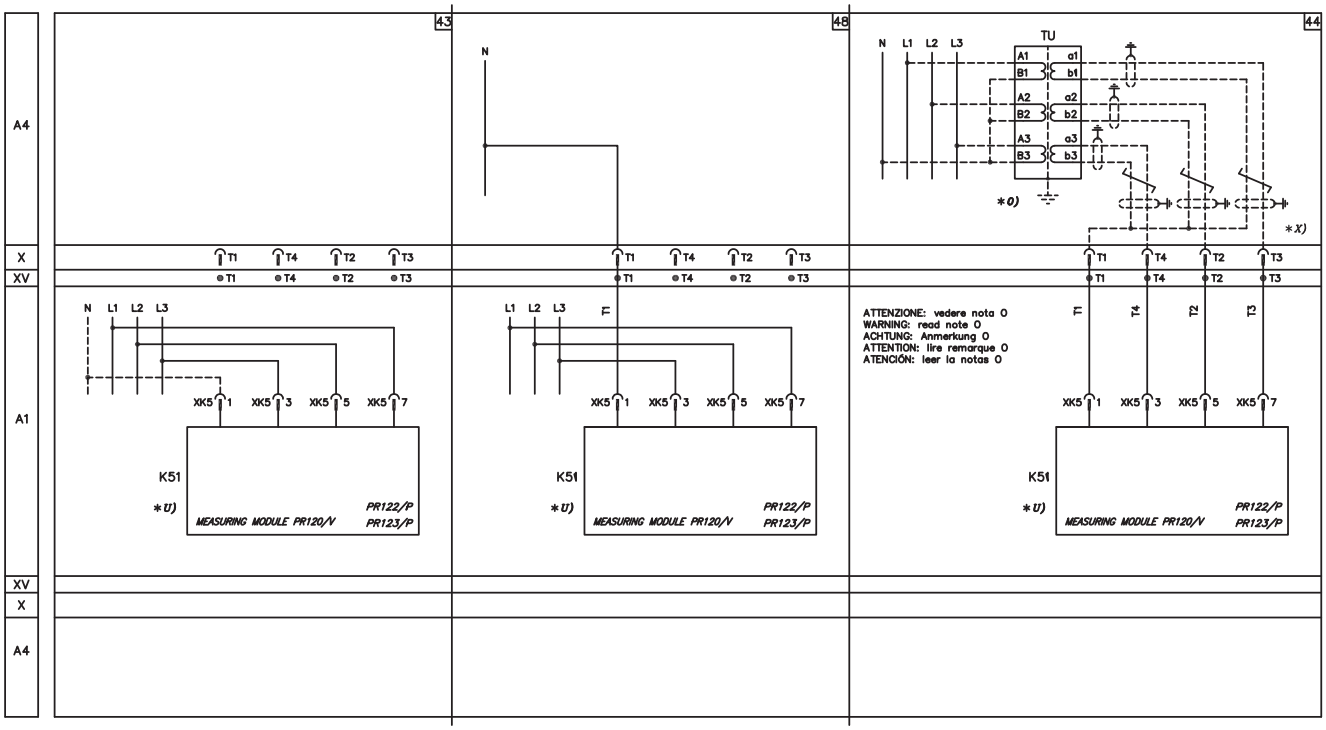


Model	L2234	L4681	L5439	Apparatus	Emax	Scale
	L2778	L5179				
				Doc. no.	1SDH000460R0002	Page No 158/161

Auxiliary circuits of the PR121, PR122 and PR123 releases

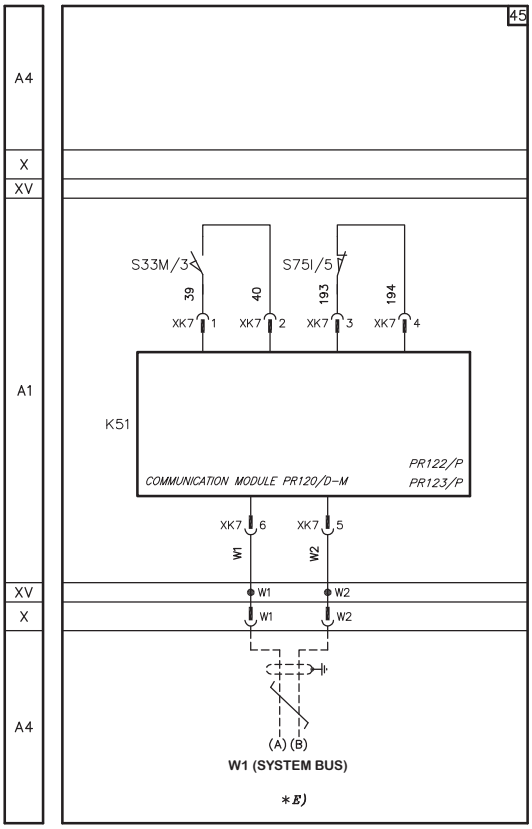


PR120/V measuring module

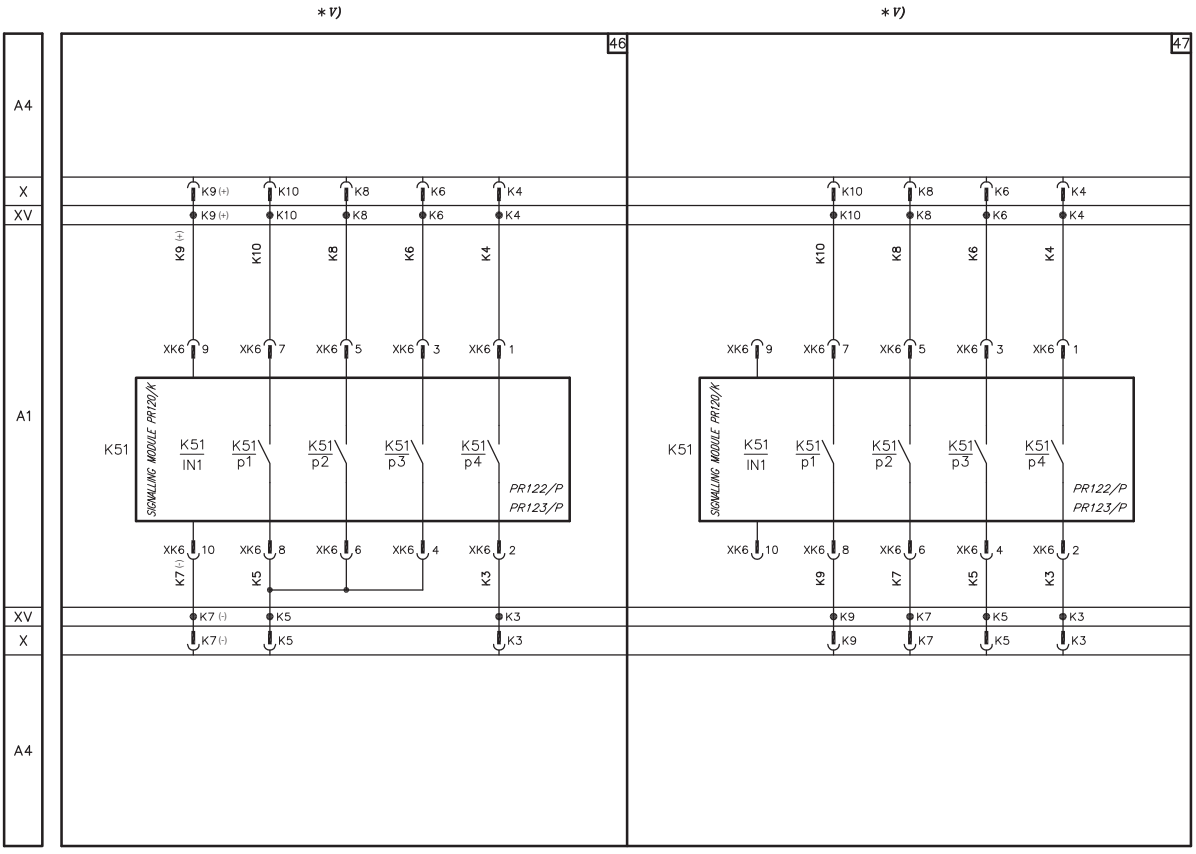


Model	L2234	L4681	L5439	Apparatus	Emax	Scale
	L2778	L5179				
				Doc. No	1SDH000460R0002	Page No 159/161

PR120/D-M communication module

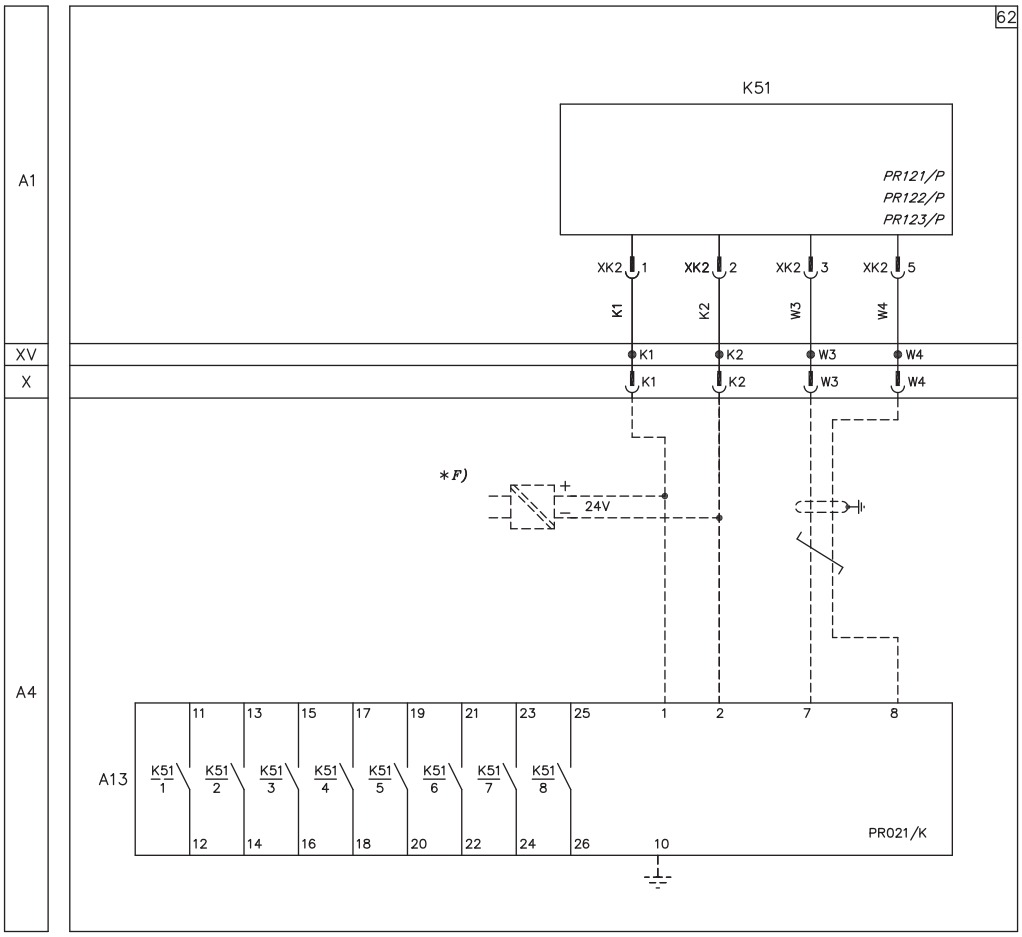


PR120/K signalling module



Model	L2234	L4681	L5439	Apparatus	Emax	Scale
	L2778	L5179				
				Doc. no.	1SDH000460R0002	Page No 160/161

PR021/K signalling unit



Model	L2234	L4681	L5439	Apparatus	Emax	Scale
	L2778	L5179				
				Doc. No	1SDH000460R0002	Page No 161/161

Due to possible developments of standards as well as of materials, the characteristics and dimensions specified in the present catalogue may only be considered binding after confirmation by ABB SACE.

1SDH000460R0002 L5439

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